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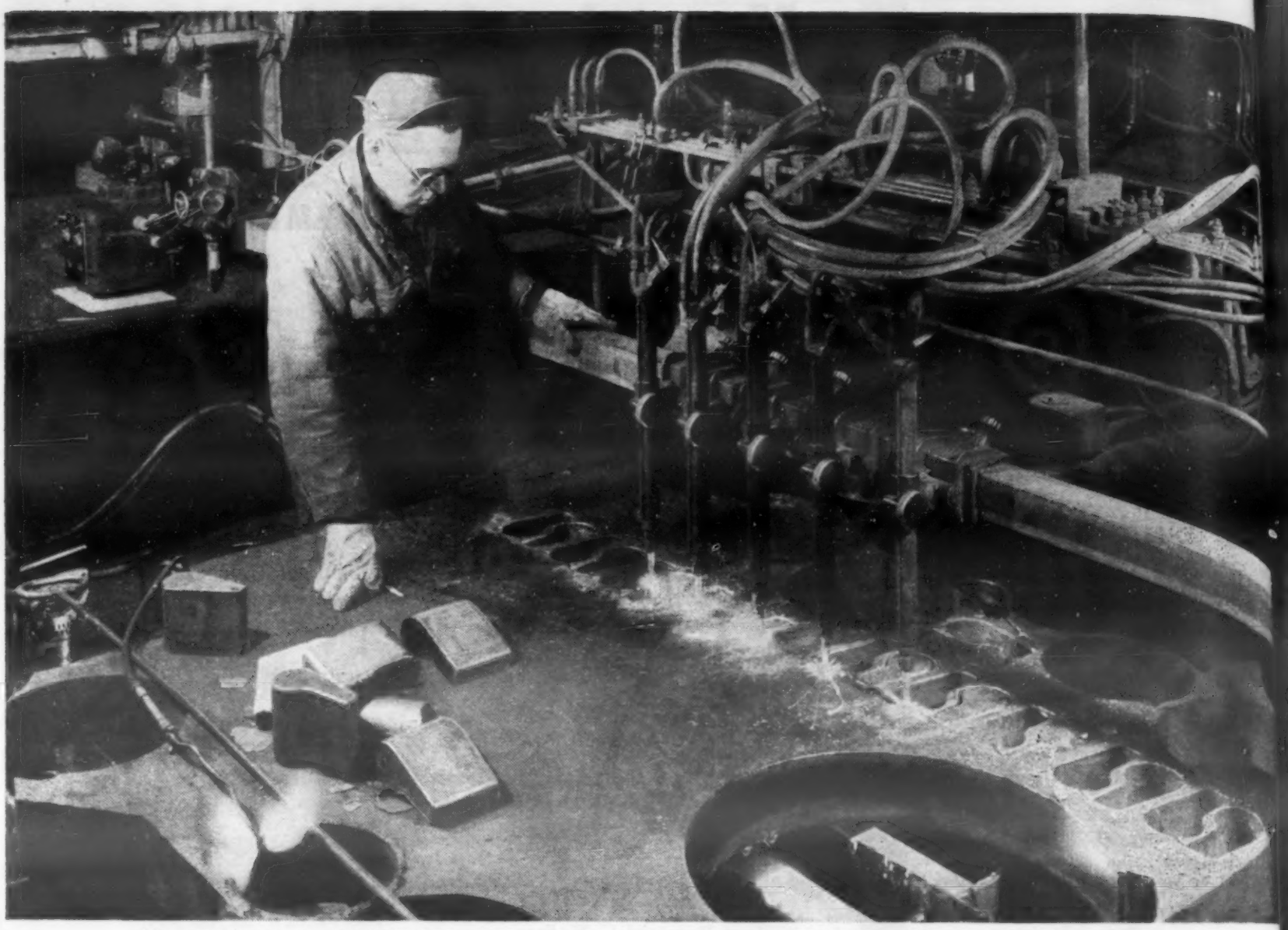

The metal box, upper left behind operator, contains electronic tracing device which follows sketch and guides cutting torch.

New Electric Eye Machines Speed Ryerson Cutting Service

The multiple-torch gas cutting machine shown above is one of eleven recently installed in Ryerson plants from coast to coast. Equipped with an electronic eye tracing device, these remarkable new machines cut the most intricate shapes swiftly, accurately. Time spent in preparing wood and metal template making is eliminated. Instead the electric eye follows a simple sketch or blueprint within plus or minus fifteen-thousandths of an inch!

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News Digest

Metal Show Attracts Record Crowds in Cleveland

The annual Metal Show held dur-g the week of October 17 at the ublic Auditorium in Cleveland, hio, was one of the most successful history, at least from the stand-oint of attendance. A 40,000 at-ndance was predicted, but this figure as exceeded in the first three of the ve days. Many exhibitors reported at a fair percentage of those visit-g the show displayed genuine in-rest in displays or sought specific nformation.

In a show as large as this one, hich was spread over a vast area as as presented by Cleveland's Public uditorium, it is difficult to look ack and pick out any one outstand-ng development to cite as the one oint of interest in the show. How-ver, several trends were apparent, ncluding the use of displays in which ome action takes place. The reason an be seen in the fact that welding, asting and finishing displays where ome actual operation was going on never seemed to be lacking for in-erested spectators.

This year the latest metal—ti-anium—went on exhibit for the first ime. Two or three industry booths, as well as one of the U.S. Armed Service displays, showed metallic ti-anium in any one of several forms, ncluding tubing, forgings, sheet and the metallic sponge developed in the early stages of converting the ore into usable metal. Since, with the excep-tion of government uses, titanium has only been applied experimentally up to this point, little could be told about actual service characteristics of the metal. Many people who had only heard of titanium were, however, given a chance to see and feel the metal that could well be the most important metal of the coming gen-eration.

Judging by the number of displays and the interest shown in the dis-plays, precision parts are due to receive considerable attention from industry in general. Innumerable dis-plays were devoted to die castings, precision castings made by both "lost" wax and frozen mercury methods, metal powder parts, and other parts which require little or no machining or finishing before use.

In addition to the small castings or formed parts previously referred to, there were numerous other casting displays. Although malleable and gray iron casting were presented by the displays of their respective foundry societies, many individual foundries took display space to show castings being produced for special service re-quirements. Primarily, such castings were for either heat or wear resis-tance, or both.

In the field of welding, most atten-tion was given to new developments in the use of inert gas-shielded arc welding. Several displays featured this method, including that of an alumi-num company making souvenirs in its booth. Outstanding development in this field is the extension of a gun-welding method to permit its use on aluminum plate up to 3 in. thick. The same method is also extended to ferrous metals. Unlike earlier inert-gas welding methods, the new method makes use of an expendable electrode which is fed in wire form through the gun.

Heat treating, particularly those methods which accomplish their heat-ing function quickly, likewise came in for considerable attention. New salt bath methods vied with induc-tion heating and high-speed gas heat-ing for prominence. This year's show probably saw more induction heating equipment than at any previous show.

The Army Ordnance Department showed examples of shells which had been produced by cold extrusion. The cold extrusion method had been de-veloped by the Germans for use in World War II. Soon after peace, American investigators picked up the process and have been successful in extending the process way beyond the low carbon steels to which it was limited in Germany.

As far as metals are concerned, the Metal Show is still only partially representative. While most of the nonferrous metals were represented by one or more exhibitors, steel pro-ducers were conspicuous by their absence. With the exception of a few specialty steel companies showing their wares, there was only one steel exhibit, and that was of a distributor showing a remarkable new free-ma-chining steel.

Next year's show has been sched-uled for Chicago, Ill., the scene of the 1947 show.

Cavitation Corrosion Attributed to Microcells in Metal Crystals

In a recent investigation of cavi-tation corrosion, G. Petracchi (*La Metallurgia Italiana*) found that cavi-tation is initially destructive, not be-cause of the mechanical stresses to which it gives rise, but because these stresses are associated with a corrosive action primarily due to electrical effects.

Corrosion due to cavitation, a phe-nomenon for which various theories have been preferred, occurs in marine propellers, hydraulic machines, con-densers, etc. It is characterized by the liquid detaching from, then imping-ing upon the surface of the metal. This action is accompanied by forma-tion of vacuum pockets in the liquid, liberation of gases normally dissolved in the liquid, and local corrosion of the metal.

In this phenomenon, the metal can operate as an anode and as a cathode. The electric currents are generated by microcells set up in adjacent crystals as a result of alternating mechanical stresses and the motion of the liquid.

Further investigations on this prob-lem are being conducted.

Zinc, Cadmium, Tin Deposited on Aluminum by Chemical Process

A new process for depositing zinc, cadmium and tin by chemical displacement upon aluminum was the subject of a paper published in *Metal Industry* (Sept. 23) by S. Heiman.

A dilute hydrofluoric acid dip was used to remove gross oxide and to activate the surface of the aluminum preceding the immersion dip. The film remaining on the aluminum after the cleaning treatment can be removed by dissolving in 70% (by volume) nitric acid at room temperature and rinsing in cold water.

Immersion solutions contain the metal sulfate, hydrofluoric acid or the fluoride ion, and various addition agents. For zinc, 0.5N acid concentration was used and immersion time was not critical, 30 to 60 sec. giving best results. Temperature should be kept between 68 and 77 F. Aluminum alloys successfully plated by the zinc immersion process are 24ST, 52S and 61ST.

In cadmium deposition, good agitation of the aluminum was found necessary to produce deposits of uniform, sound structure, and time of dip was more critical than with zinc, ranging from 5 to 15 sec. Good agitation and careful attention to optimum dip time were also found essential to successful tin deposition. The lower the stannous sulfate and the higher the hydrofluoric acid concentrations, the shorter the time for good tin deposits. In general, the maximum immersion time is about 10 sec.

All deposits were tested by their success in holding copper plates. Best results were obtained with zinc immersion coatings, although a special cyanide copper strike on the zinc prior to plating from the copper pyrophosphate bath was found necessary. The range of metal sulfate-hydrofluoric acid concentrations in which adherent copper deposits were obtained was much smaller with cadmium immersion coatings than with zinc. However, the results were much better with this system than with the cyanide cadmium solution. A wide range of tin immersion concentrations appears feasible, and these deposits are superior to those obtained from the stannate bath as bases for further plating.

Cracking of Aluminum Alloys During Welding Investigated

A step toward a practical solution to the problem of cracking during the welding of aluminum alloys is described by W. I. Pumphrey in *Metallurgia* (Sept.). The work described in this paper was carried out by the University of Birmingham and sponsored by the Aluminum Development Association.

Pumphrey and his associates analyzed mathematically the conditions governing the occurrence of cracking at temperatures above the solidus in a straight butt weld between two parallel and restrained sheets of an aluminum alloy. From this analysis they developed a method of estimating the effect of changes in physical properties of aluminum or in welding technique upon weld cracking.

Cracking appears to be increased by increases in (1) brittle temperature range of the metal in the weld pool, (2) rate of cooling of the solidifying weld metal, (3) speed of welding, (4) degree of restraint imposed on the abutting sheets during welding, and (5) thermal conductivity or linear coefficient of thermal expansion of the aluminum alloy. It is possible to decrease the brittle temperature range of the metal in the weld pool by welding the base metal with a filler rod of the same alloy series but of higher alloy content, and possibly containing a small amount of some addition specifically designed to reduce the crystal size of the metal in the weld bead.

Cracking at temperatures below the solidus does not generally occur in welds because of the low stresses to which they are subjected during cooling. When present it may be decreased by (1) ensuring adequate ductility in the metal to be welded, (2) designing the form and welding technique to minimize restraint and stress-raising effects, and (3) reducing cracking at temperatures above the solidus. Fine cracks formed above the solidus temperature may initiate cracking below the solidus when metal contraction is restrained. In general, however, cracking above and below the solidus are two separate problems and may or may not occur together.

Oxygen, Nitrogen Penetration in Zirconium Sets Heating Limits

Practical limits for the heating of zirconium in air, oxygen and nitrogen and the possibilities of producing hard surface coatings on zirconium have been explored by E. T. Hayes and A. H. Roberson of the U. S. Bureau of Mines (*Journal of the Electrochemical Society*, September).

Gain in weight data and metallographic examination were used to establish temperature limits for zirconium in various atmospheres for appreciable periods of time. Limits obtained are 1470 to 1650 F for normal air, 1470 F for dry oxygen, and 1650 to 1830 F for dry nitrogen. It is apparent that absorption of nitrogen by zirconium occurs at a much slower rate than absorption of oxygen. It is also evident that the absorption of these impurities passes safe limits in the range 1650 to 1850 F. This increase in penetration is believed to be connected in some way with the allotropic transformation from alpha to beta zirconium at 1584 F.

Surface hardness values close to Rockwell C 65 can be attained by heating in dry air, oxygen or nitrogen at elevated temperatures. The hard films can be produced by heating 1 hr. at 1470 F in oxygen or dry air, or 24 hr. at 2190 F in dry nitrogen. The oxide surface retains its hardness without flaking for a few hours' exposure at 1110 F in air, but the nitride coat is somewhat brittle and would be restricted to use in air at temperatures below 750 to 930 F. The voluminous nature of the oxide formed by decomposition of the nitride in air suggests that nitrogen, as well as oxygen, is involved in high-temperature corrosion in air. The hard oxide coats appear to have better bonding and stability in air, as well as grain size control; potentially, they have much wider application.

Patents Granted on Ductile Cast Iron

Two patents on ductile cast iron have been granted to International Nickel Co., according to an announcement made before the Gray Iron Founders' Society annual meeting. At the same time, Inco stated that more than 40 companies are licensed to produce the new iron. The iron has greater strength than ordinary cast iron, plus greater ductility and shock-resistance.

Advances in Gray Iron Are Discussed at A.S.T.M. Symposium

The current high interest in gray iron as an engineering material was demonstrated last month by the Cast Iron Symposium held at the A.S.T.M. First Pacific Area National Meeting in San Francisco. The four papers presented there were highly informative, and taken together they gave an over-all picture of the properties and uses of gray cast irons and a view of recent developments in the field.

The paper by C. K. Donoho, American Cast Iron Pipe Co., entitled "Mechanical Testing and Properties of Gray Cast Iron," presented typical tensile test data for gray irons in the 20,000 to 60,000 psi. class (A.S.T.M. Spec. A48-48).

The correlation between the hardness and strength of a gray iron casting was demonstrated, and it was brought out clearly that a much better correlation is possible if the gray irons are inoculated previous to casting. It was also shown that impact values closely follow resilience of a given iron, *i.e.*, the area under the stress-strain curve in transverse testing, and that compressive strength of gray iron correlates very well with Brinell hardness.

In the testing of nodular iron, Mr. Donoho said that the use of a keel block specimen was considered mandatory if the full tensile values possible with this material are to be developed. The tensile-hardness relationship for nodular iron more nearly approaches steel than gray iron, and most nodular irons possess tensile strengths intermediate between that of steel and flake graphite gray iron.

Mr. Donoho concluded that, as would be expected, either increasing section size or increasing carbon equivalent tend to lower the strength values and hardness of gray iron. Inoculation produced irons more consistent and predictable as concerns physical properties than uninoculated irons. The high ratio of tensile strength to hardness following such treatment produces maximum toughness measured by impact testing. As concerns nodular graphite irons, their properties were believed to be best measured by using a transverse test with a complete stress-strain curve or by the use of tensile specimens made from keel block coupons. Nodular graphite gray irons, although having tensile strengths considerably higher than the usual flake graphite irons, exhibit a compressive strength-Brinell ratio very similar to normal flake graphite iron.

The paper, "Automotive Cast Irons, Including Brake Drums," by R. G. McElwee discussed in some detail automotive irons, both as used in miscellaneous castings, cylinder blocks, brake drums and clutch plates. It is obviously his feeling that relatively high carbon irons should be employed whenever possible because of the decreased shrinkage, easier castability, and high machinability of such irons as compared to lower carbon types. Similarly, he observes that a 35,000-psi. iron of known and proven soundness is often to be preferred in many applications to a higher strength iron with a greater tendency to defects or porosity at junctions of light and heavy sections. High carbon becomes a must in the case of materials such as brake drums that are required to resist heat checking. When higher strength is required in such applications, he feels it should be obtained through the use of alloying elements rather than by reducing total carbon content.

The unique properties of gray iron that make it an essential component in some 150 basic industries were discussed in the paper "Applications and Uses of Gray Iron Castings, Including Significance of Various Properties of Gray Cast Iron," by C. O. Burgess, Gray Iron Founders' Society. It was pointed out that the large number of existing specifications for gray iron is evidence of the wide application of the material in industry.

In addition to the mechanical strength and rigidity possible with gray iron, its high castability, unusual wear resistance, corrosion resistance, machinability, damping capacity, freedom from notch sensitivity and ability to harden without distortion, are of fundamental importance in its wide commercial application. Included in this paper was a review of progress in the use of gray iron at elevated temperatures and a record of the recognition so far obtained from the A.S.T.M. and the A.S.M.E. Boiler Code Committee relative to extending the permissible temperature ranges within which controlled gray irons can be employed.

Nodular graphite gray iron was also briefly considered, and it was pointed out that the great strength, ductility and high modulus of elasticity of nodular irons will eventually extend the engineering applications of gray iron very materially but will require a new set of specifications.

The future status of gray iron and the means of rendering the product increasingly valuable to industry were considered. The future appears to be bright in view of the fact that the casting process itself is unique as concerns effective metal placement; gray iron is generally accepted as the most economical of existing metals as concerns unit cost; and last, gray iron possesses the unusual combination of essential engineering properties just described. Because of its widespread character, however, coordinated efforts through technical societies and the trade association of the gray iron industry will be necessary to assure its continued advance and development to meet modern engineering demands.

The development of specifications in the gray iron field was covered by H. Bornstein, Deere & Co., in his paper "Development, Significance and Uses of Specifications for Cast Iron."

He noted the striking revisions that have been necessary in the last 30 years to keep track of the advances in this field. This is particularly true in regard to higher strength classes of iron (up to a 60,000 psi. minimum tensile strength). He also emphasized the uses and abuses of specifications. Specifications, for example, can promote improvement in the product and research directed towards future improvement as well as mirror advances in the industry. One of the abuses of specifications is to insist on higher strength materials than are required for a given application, with the result that there is an unjustified increase in cost of production, and properties such as machinability suffer. Despite occasional abuses, it was observed that specifications for gray iron serve a definite need in industry and can be intelligently used to obtain maximum performance with economy.

In the discussion following the papers, a considerable amount of interest was shown in the nodular gray irons, briefly mentioned in two of the papers. This interest was directed towards the best type of nodulizing alloy, methods of adding magnesium or the nodulizing alloy, and the potential importance of such irons in the whole metallurgical field.

Reported by C. O. Burgess, Technical Director, Gray Iron Founders' Society, Inc.

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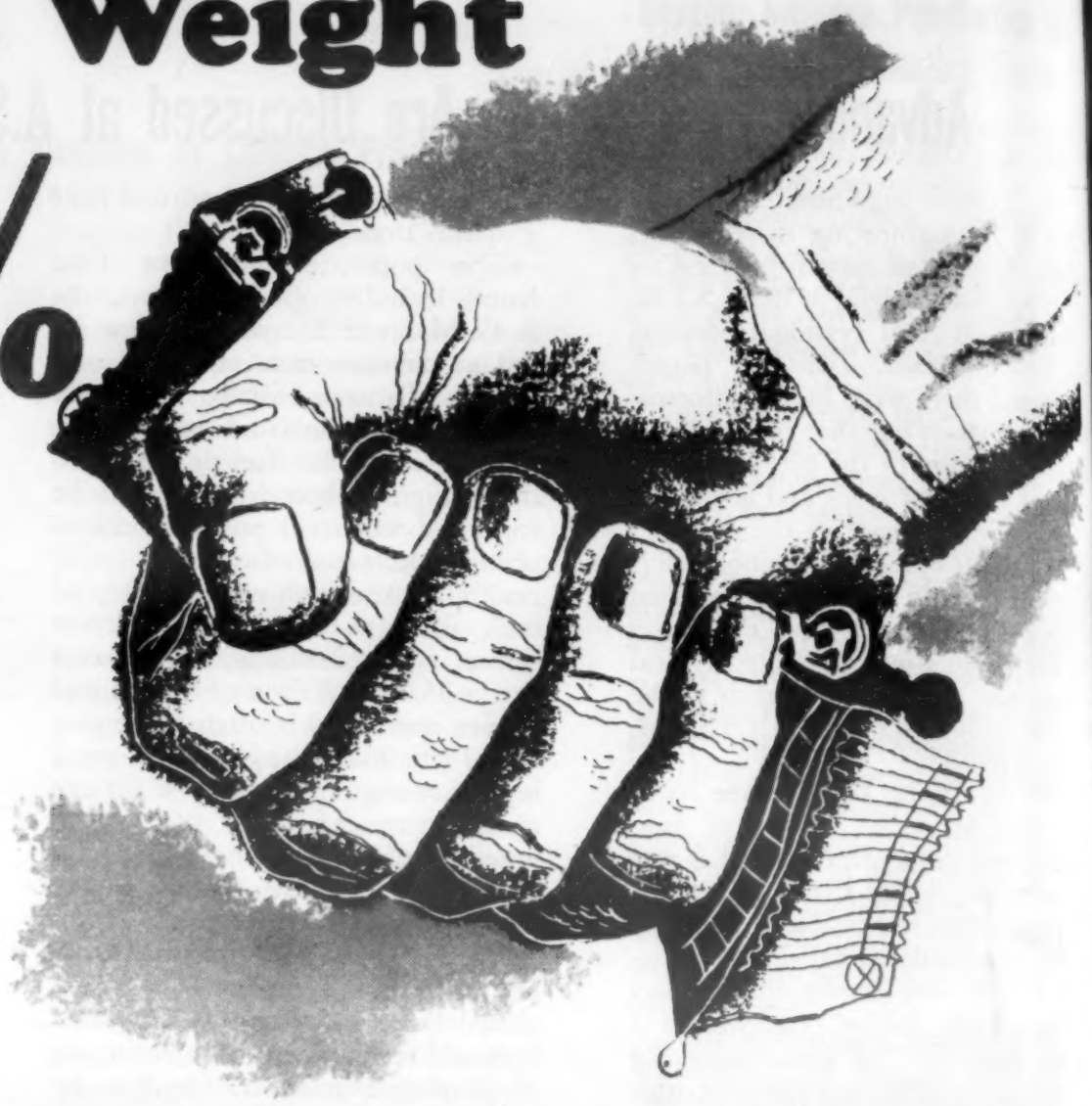

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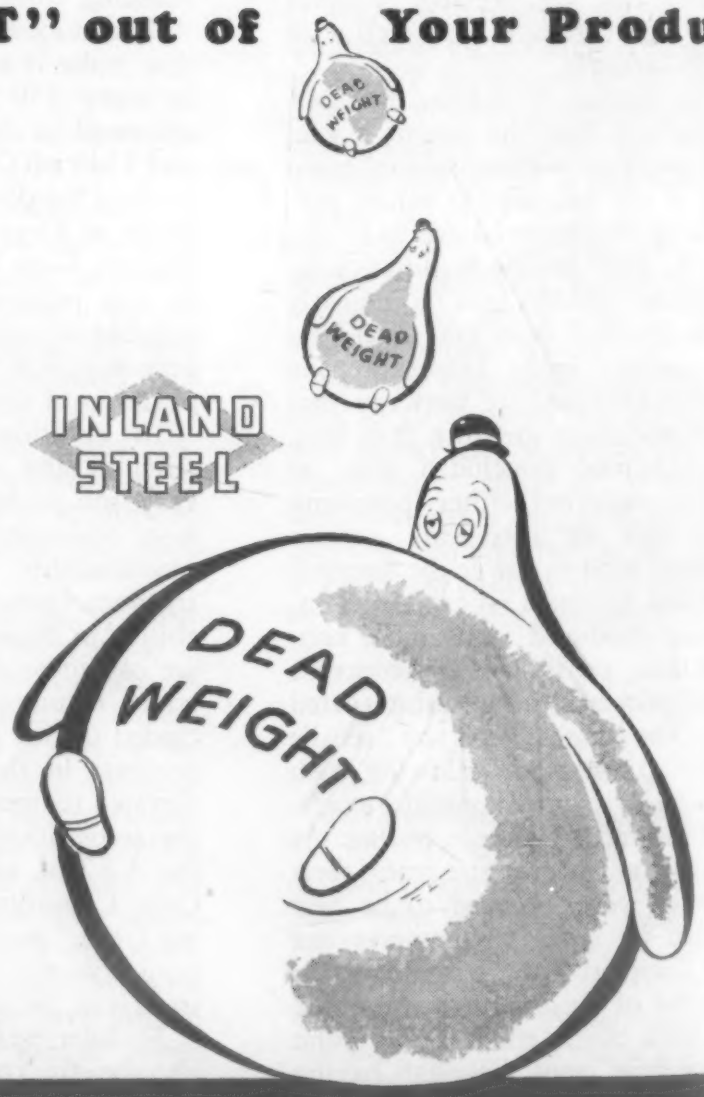

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How Plastic Deformation Influences Design and Forming of Metal Parts

Part 1-True Stress-Strain and Initial Plastic Flow

Here is a clear and simple explanation of plastic flow in metals and how application of knowledge gained to date on the subject can be used to advantage in the design and production of metal products.

by JOHN R. LOW, JR.,
Research Laboratory, General Electric Co.

• THE WIDE USE of metals as engineering materials results not only from their mechanical strength and other service properties, but also from the fact that metals can be deformed plastically. That copper possesses a high electrical conductivity would be of considerably less importance if copper could not be rolled into rods and drawn into wire. Similarly, the desirable magnetic properties which can be developed in certain of the iron-silicon and iron-nickel alloys could not be used to their full advantage in many applications if we were limited to melting and casting as the only available methods of fabrication.

In spite of the tremendous importance of plastic flow in metals, the knowledge that has been gained about it and the factors affecting it is still not being applied as widely in actual practice as it might be. This is perhaps largely due to the fact that engineers and production people are still not sufficiently acquainted with the developments in this field. Therefore, the purpose of this and the succeeding article is to explain as simply as possible the fundamental principles of plastic deformation and how the principles can be applied to solving design and production problems.

Fundamentally, the ability of metals to deform plastically, *i.e.,* to suffer a permanent change in shape without rupture, is related to the structure of the metallic crystals and to the nature of the binding forces between the metal atoms in these structures. In general, however, the dimensions of the individual crystals are so small compared to the over-all dimensions of the pieces of metal with which we have to deal that we can, for many purposes, disregard their crystalline nature. Therefore, in the discussion of plastic deformation which follows we shall for the most part treat the metal as an isotropic, homogeneous body.

Some Definitions

How a metal behaves mechanically is conveniently described in terms of the observed relation between stress and strain when the metal is subjected to external forces. In the tension test, for example, we apply a continuously increasing load to one end of a cylindrical bar with the other end fixed and observe the change in length of the bar. The numerical value of the load at any instant divided by the cross-sectional area of the bar at the same instant is the *stress* applied to the bar. The observed increase in length of the bar, or of a particular gage length marked on the bar, divided by the original length is the longitudinal *strain* in the bar.

By making simultaneous observations of the load and the length of the bar during the test, we obtain a *load-extension* curve for the material. This load-extension curve is very commonly, but erroneously, called the stress-strain curve for the material. It is more accurate to refer to it as the *nominal* stress-strain curve. During the early part of the tensile test when the strains are small and the dimensions of the test bar have not changed greatly, no great error results if the stress is computed by dividing the applied load by the original cross-sectional area of the bar. If, however, the length of the bar increases appreciably, the cross-sectional area supporting the load is correspondingly reduced and the *true stress* will be considerably higher than that computed if the original area is used for the computation. Similarly, in computing the strain from the observed increase in length of the bar, it is satisfactory to compute the strain by dividing the increase in length by the original length, when the strains are small. For large strains, however, it is essential that each increment in length be divided by the length of the bar just before the increment occurred if we are to avoid distortion of the stress-strain curve.

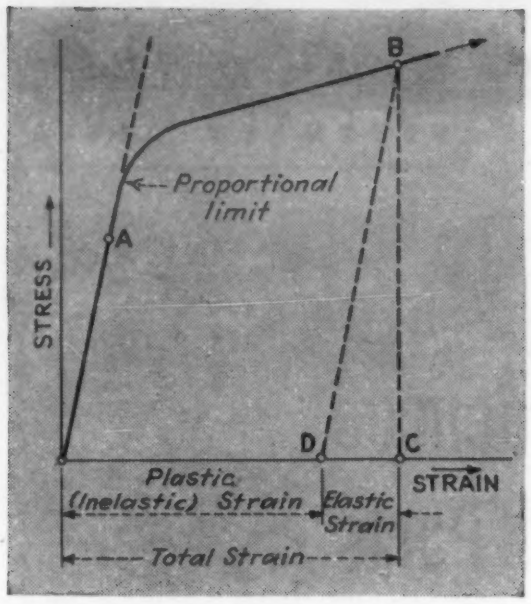


Fig. 1—Initial portion of stress-strain curve (Gensamer).

The strain computed in this manner is called the *true-strain* or *natural strain.* These alternative methods of computing stress and strain in the tension test are shown below:

$$\text{True stress} = \frac{P}{A}$$

$$\text{Nominal stress} = \frac{P}{A_0}$$

$$\text{True strain} = ln \frac{l}{l_0}$$

$$\text{Nominal strain} = \frac{l - l_0}{l_0} = \frac{l}{l_0} - 1$$

P = load; A = actual area after straining; A_0 = original area; l = actual length after straining; l_0 = original length; *ln* = natural logarithm.

Table I will serve to give some idea of the magnitude of the differences between these two methods of defining stress and strain.

Stress-Strain Relations for Metals

In Fig. 1 is shown the initial portion of the stress-strain curve for a typical metal. The first part of this curve is a straight line, *i.e.,* the strain is directly proportional to the applied stress. Furthermore, in this portion of the curve the material is elastic; for example, if the stress is increased to point A and then decreased to zero, the specimen will return to its original dimensions. At some higher value of stress the curve begins to deviate gradually from the original straight line at a point called the *proportional limit.* The *elastic limit,* that is the stress required to produce the first detectable permanent increase in length, is generally very nearly the same as the proportional limit. If, at any point on the curve beyond the elastic limit, for example Point B, the load is removed, the specimen will contract elastically but will not return to its original dimensions. The amount of permanent deformation which has occurred is the *plastic strain.*

The curve shown in Fig. 1 is typical of most nonferrous metals and of many steels; but steels in general, particularly when in the annealed or normalized condition, exhibit a *yield-point* rather than the gradual type of yielding. The *yield-point* is characterized by a drop in load at the beginning of plastic deformation and a considerable extension at substantially constant load as shown schematically in Fig. 2. The stress at the point marked Y^l is called the *upper-yield-point;* that between points B and A the *lower-yield-point;* and the elongation occurring between points B and A the *yield-point elongation.* During the extension at substantially constant load in the tension test the deformation does not occur uniformly along the length of the specimen. Deformation proceeds by the formation of discrete bands of localized deformation which then spread out along the length of the specimen. These regions of localized flow are known as "Lueders-Lines," and they will continue to form and increase in width as the specimen is elongated until all of the specimen has been deformed in this manner. At an average extension corresponding to Point A in Fig. 2, the entire length will have been deformed in this manner and from this point to the maximum load, deformation is uniform throughout the length.

The magnitude of the yield-point elongation and the depth of the surface markings associated with inhomogeneous yielding of this type varies considerably in steels, depending upon the composition and heat treatment. It is most marked in steels containing large amounts of free ferrite such as the lower carbon grades of sheet steel, where yield-point elongations up to as much as 5.0% may occur. This peculiar type of initial yielding behavior is responsible for the formations of "stretcher-strains" in the deep drawing of steel sheets and for "fluting" or "panelling" in bending flat rolled steel products.

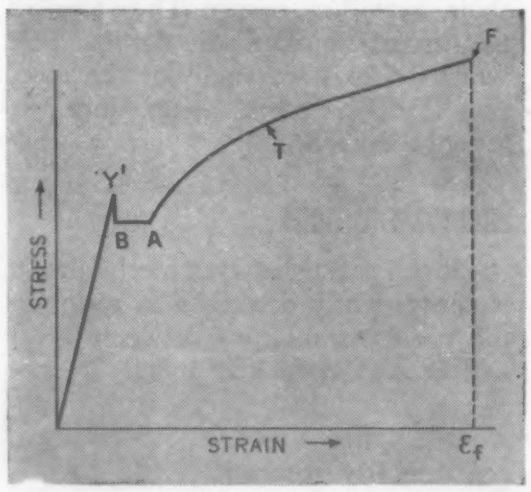


Fig. 2—Initial portion of stress-strain curve of a metal with yield point (Hollomon).

Thus far we have limited the discussion of mechanical behavior of metals to the elastic portion of the stress-strain curve and to the very early stages of plastic deformation. In this region no distinction need be made between the nominal stresses and strains and the true stresses and strains. As deformation proceeds, however, the dimensions of the specimen begin to change appreciably, and a distinction must be made if the stress-strain curve is to serve as an accurate description of the mechanical behavior of the material.

Fig. 3 is a comparison of the nominal stress-strain and the true stress-strain curves for 0.05% carbon steels. The nominal stress-strain curve would indicate that at first an increasingly higher stress is required if plastic deformation is to continue; the stress required to cause plastic deformation finally reaches a maximum, and beyond this maximum deformation proceeds even though the stress is decreasing; and that finally fracture occurs when the stress has fallen to a value very much below the maximum. The true behavior of the metal is actually quite different. In the true stress-strain curve of Fig. 3 we see that the metal actually strain-hardens in a perfectly regular manner, the rate of strain-hardening decreasing continuously up to the point at which rupture occurs. The rupture stress in this case is the highest *true stress* which the material is able to support.

The distorted picture of the mechanical behavior of the metal which results when nominal stresses and strains are used to describe this behavior is in part due to the fact that the phenomenon known as necking occurs in the ordinary tensile test. As a tension specimen is elongated by plastic flow, its cross-sectional area supporting the load is reduced. The increase in *stress* which results from this decrease in area is offset by the fact that the metal strain hardens and is therefore able to support a greater load despite the fact the cross-sectional area is less. However, the rate of strain-hardening, *i.e.,* the slope of the curve, continuously decreases

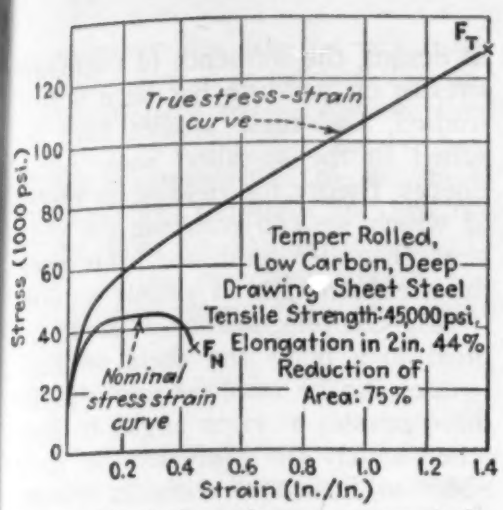


Fig. 3—Nominal and true stress-strain curves for SAE 2345.

as deformation proceeds. At some point in the test the rate of strain-hardening falls below the value necessary to offset the increase in stress resulting from the increase in load and the decrease in area. From this point on any local region which, due to inhomogeneities in the bar or in the cross-sectional dimensions, is deformed slightly more than neighboring regions can no longer "pass-on" the deformation by strain hardening, and the deformation is localized. As the test proceeds this localization becomes more marked, the cross-sectional area at one point is greatly reduced, the load necessary to continue flow in the "neck" decreases, and the specimen finally fractures.

The result of this necking is that the numerical value of the elongation to fracture in the tensile test when computed as a nominal strain, *i.e.*, the fractional increase in length of some arbitrary initial gage length, will be markedly dependent upon the initial gage length chosen. This variation of total elongation to fracture with initial gage length is shown for a number of metals in Fig. 4.

It is perhaps desirable at this point to emphasize the fact that when we have carried out a standard tension test on a piece of metal we have merely determined its mechanical behavior under one particular set of conditions. These conditions for the ordinary tension test are: (1) Uniaxial tensile stress. (2) Room temperature. (3) Average rate of deformation approximately 0.05 in./in. per min. (4) Direction of deformation unchanged during the test.

If we wish to make use of the results obtained from the simple tension test to predict the behavior of a metal under another set of conditions, we must know the manner in which a change in any one of the above conditions will influence this behavior. For example, in a structure or a machine part we seldom duplicate the first condition listed above. In general, the metal is likely to be subjected to loads applied in several directions simultaneously and we must, therefore, know how its behavior under combined stresses differs from that under a simple tensile stress. In most forming operations, such as the bending of a plate or the drawing of an automobile fender, all of the conditions will differ from those existing during the tension test.

If we knew precisely the manner in which a change in these "external" variables changed the mechanical behavior, we could then use the simple tension test to measure the mechanical properties in a fundamental way and could then expect to predict accurately the behavior under any other set of conditions. The influence of these separate variables is yet to be investigated completely and the results embodied in a general theory of plastic flow. However, considerable progress already has been made.

While a complete knowledge of the influence of the external variables (stress combination, temperature, strain rate, and direction of straining) is essential if we are to make the fullest use of the metallic materials available to us, of even greater

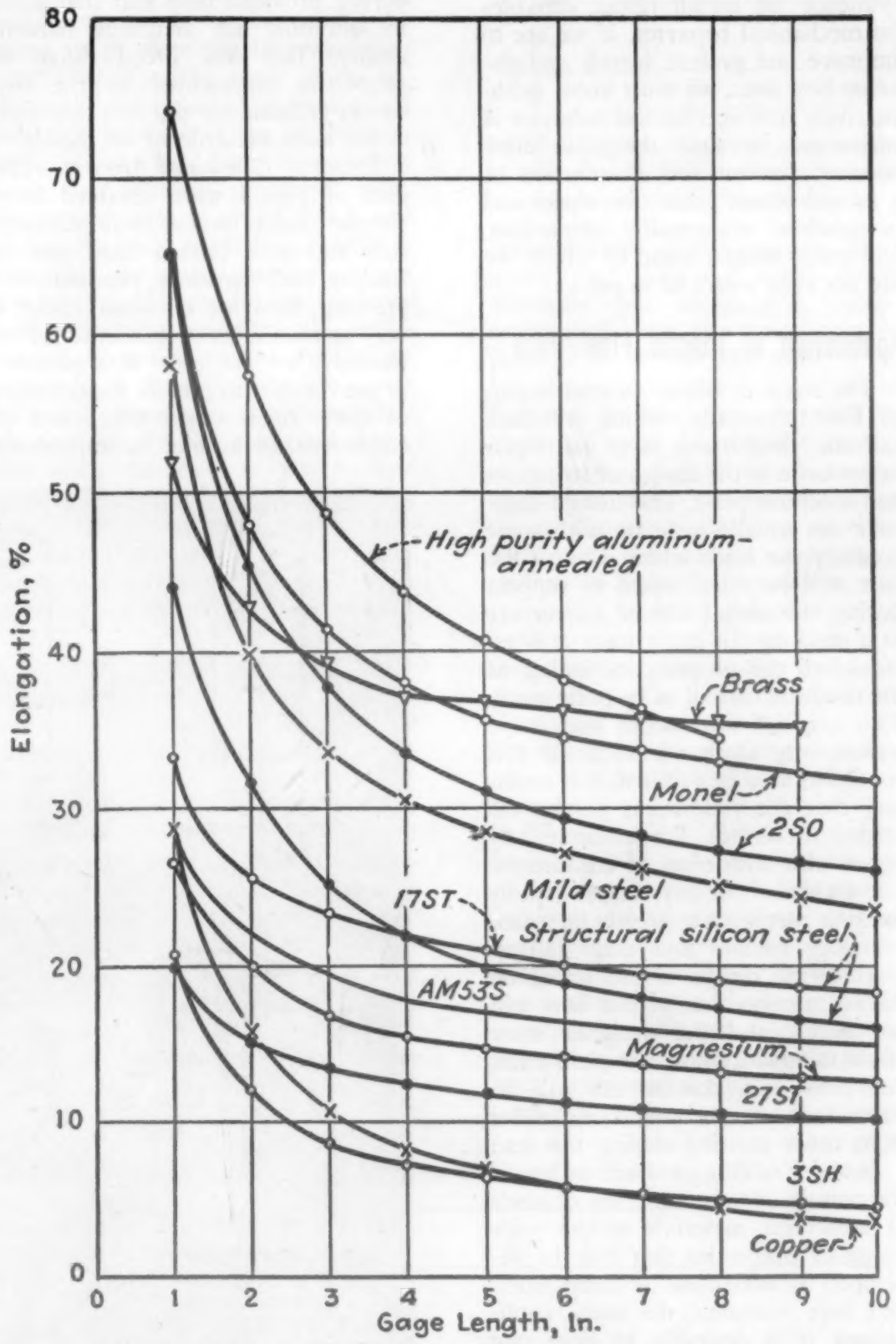


Fig. 4—Nominal strain to fracture in tension test as a function of initial gage length. (Templin & Sturm)

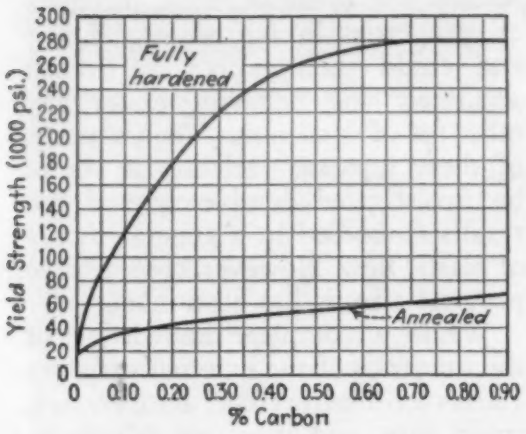


Fig. 5—Variation of yield strength with carbon content.

importance is a knowledge of the influence of metallurgical variables on mechanical behavior. If we are to improve our present metals and develop new ones, we must know quantitatively how mechanical behavior is influenced by such things as alloy content, amount and distribution of a second phase, grain size, shape and orientation, nonmetallic impurities, and many others, some of which we are not even aware of as yet.

Application of Plastic Flow Data

The stress at which a metal begins to flow plastically, which we shall call the *yield-stress,* is of particular importance in the design of structures and machine parts. The design engineer can usually estimate with some accuracy the loads which a particular part will be called upon to support during the useful life of a structure or a machine. In many cases it is essential to the proper functioning of the machine that all of its parts retain their original dimensions and shape within very close tolerances. If this condition is to be fulfilled, it is necessary that the yield-stress not be exceeded in service. For example, any appreciable distortion of an automobile crankshaft or any similar rapidly rotating part leads to greatly increased vibratory stresses and early failure. Engineering design is predicated on the assumption that plastic flow will not occur, and the designer must know in advance how the yield-stress measured in a tension-test will be affected if service conditions differ from those existing during the test.

Initial Yielding in Steels—One of the reasons for the wide use of steels as structural materials is the wide range of properties that may be developed by variations of composition and heat treatment. In many applications it is desirable to have two sets of properties in the same steel. For fabrication involving plastic deformation, such as forging, stamping, flanging, machining, etc., it is desirable to have a material with a low yield stress and a considerable degree of ductility. On the other hand, if the formed part is to be used as a load carrying member, it is desirable to have the yield-stress as high as possible. Fig. 5 shows the variation of room temperature yield-strength with carbon content for steels in the annealed condition as well as the yield strengths of these same steels in the fully hardened condition. For a given carbon content, it is possible to develop any yield-strength between the limits set by the upper and lower curves, provided only that that piece in question has sufficient hardenability. The very broad range of properties represented by the two curves account for the fact that steel is the most versatile of all metals.

Effect of Combined Stresses—The data of Fig. 5 were obtained from simple tension tests at room temperature and at a certain fixed rate of loading and, therefore, represent the yielding behavior of steels under a very restricted set of conditions. Fortunately, we are now in a position to use the data to predict the behavior of these steels under other sets of conditions. Because of its importance in design, the influence of combined stresses on yielding has been widely studied, and these studies have resulted in the so-called Shear Strain Energy Theory for yielding by means of which we can compute the yield strength under combined loads given the yield-strength in simple tension.

Any complex system of loads applied to a body and their resultant stresses can be resolved into a set of three stresses at right angles to each other which are equivalent in their effect to the more complex system. These three resolved stresses are called the *principal normal stresses* and will be designated as S_1, S_2, and S_3. If tensile stresses are considered positive and compressive stresses negative, S_1 represents the greatest and S_3 the least stress in the algebraic rather than the numerical sense. For example, for a system of loading which can be resolved into two tensile stresses and a compressive stress, the greater tensile stress would be designated as S_1, the lesser tensile stress as S_2 and the compressive stress as S_3. The principal stresses and their relative magnitudes for a number of the more commonly encountered combined stress systems are shown in Fig. 6.

The general statement of the shear-

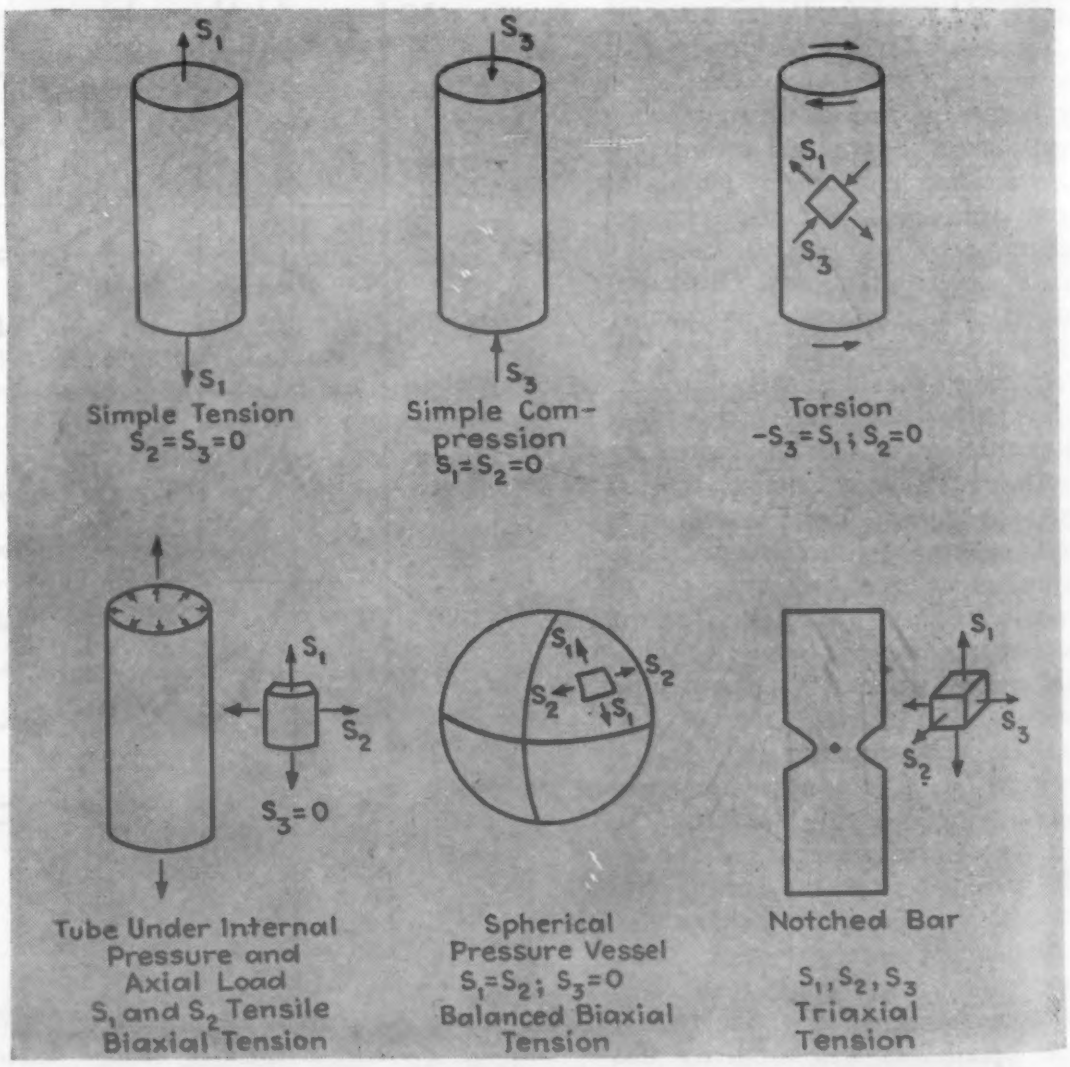


Fig. 6—Principal stresses for a number of common combined-stress systems.

strain-energy law for the beginning of plastic flow is as follows: For any combination of stresses, plastic flow will begin when the shear-strain-energy becomes equal to the shear-strain-energy required to produce plastic flow in simple tension. In terms of the principal stresses this means that plastic flow will begin when:

$$\frac{(S_1-S_2)^2+(S_2-S_3)^2+(S_3-S_1)^2}{2}=S_0^2$$

Where S_0 is the stress required to produce plastic flow in the simple tension test at the same temperature and the same rate of application of the load.

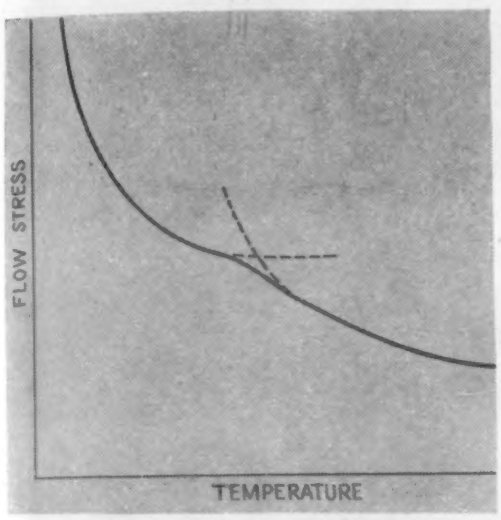


Fig. 7—Variation of yield stress with temperature for a typical steel (schematic).

For the more common case of biaxial stress systems, *i.e.,* where one of the principal stresses is zero, the above expression (for example, taking $S_2 = 0$) reduces to

$$S_1^2 - S_1 S_3 + S_3^2 = S_0^2$$

Thus, for the torsion case where $S_2 = 0$ and $S_1 = -S_3$, flow will begin when $S_1 = 0.577S_0$. For balanced biaxial tension where S_1 and S_2 and $S_3 = 0$, the theory predicts that plastic flow will begin when $S_1 = S_0$ or, since $S_1 = S_2$, when $S_2 = S_0$.

The shear-strain-energy law for the beginning of plastic flow is now widely used by engineers to determine allowable stresses under combined loads. One elementary example will illustrate the general method. Let us assume that we have a steel, which in simple tension has a yield strength of 100,000 psi., and want to know the allowable torsional stress that can be applied to a thin walled tube of this same material.

As we have seen above for the torsion case, yielding will occur when $S_1 = 0.577 \times S_0$ and S_1 equals the maximum shear stress. The maximum shear stress that can be applied to such a tube is, therefore, 57,700 psi. If it had been assumed that yielding would occur in the torsion case when the maximum shear stress reached the value of the maximum shear stress at yielding in simple tension ($\frac{1}{2} S_1$), the allowable stress calculated would have been only 50,000 psi.

Effect of Temperature—In general, it is observed for all metals that as the temperature is increased, the stress to produce yielding decreases very markedly. The study of the influence of temperature on mechanical behavior, particularly that of the iron-base alloys, has been approached from two different points of view. At temperatures of about 800 F and above, the yield stress is generally so low that the metal cannot sustain any appreciable load for an indefinite period without some plastic deformation. For this reason the design engineer is usually concerned, not with the stress below which no plastic flow occurs, *i.e.,* the yield stress, but with the rate at which flow occurs, *i.e.,* the "creep-rate" for a given stress and temperature combination. In this article we shall confine ourselves to the effect of temperature in the range below about 800 F.

The variation of yield-stress, with temperature, for a typical steel is shown schematically in Fig. 7. The "hump" in the curve is peculiar to steels and is caused by the phenomenon known as strain-aging or "blue-brittleness." Most steel, if strained slightly and then aged at room temperature, will exhibit an increase in hardness and a decrease in ductility. At more elevated temperatures this occurs rapidly enough so that the effect is appreciable in the short time required to carry out the tensile test. For this reason the whole of the stress-strain curve is raised, for example, when testing at 400 F at

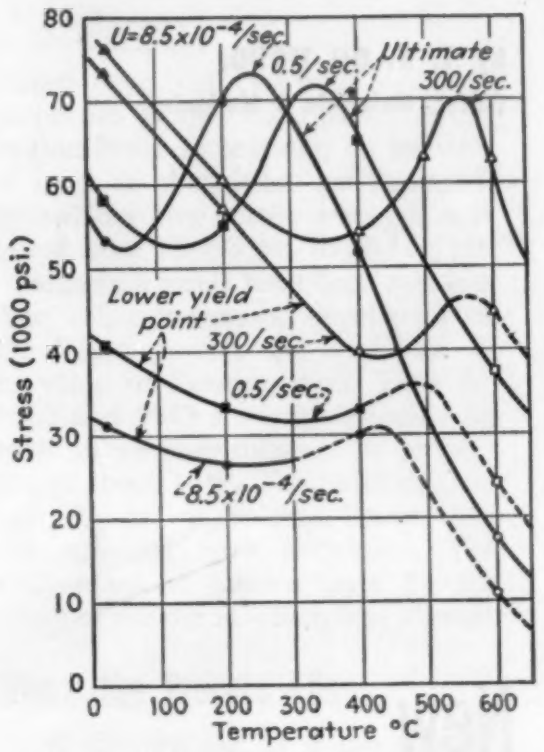


Fig. 8—Ultimate and yield point stresses of mild steel at various temperatures and rates of strain (Manjoine).

ordinary rates of deformation. Since strain-aging does not occur instantaneously but requires a certain amount of time, the range of temperature in which this effect is observed in the tension test will be influenced by the time required to make the test, *i.e.,* by the rate of deformation. Fig. 8 illustrates this manner in which the temperature of the maximum in the curve of either yield-stress or tensile strength is shifted to higher temperatures with increasing rates of deformation.

One other effect of temperature on the initial yielding is that the *yield-point-effect*—the drop in load and elongation at constant load at the beginning of plastic flow—becomes more marked as the temperature is lowered.

Effect of Strain-Rate—In general, an increase in the strain-rate, or rate of loading, acts in the opposite direction to increasing the temperature. An increase in speed of testing affects the yield-point behavior in much the same manner as a decrease in temperature. As the speed of testing is increased, the drop in load at the yield point and the yield point elongation both increase in magnitude.

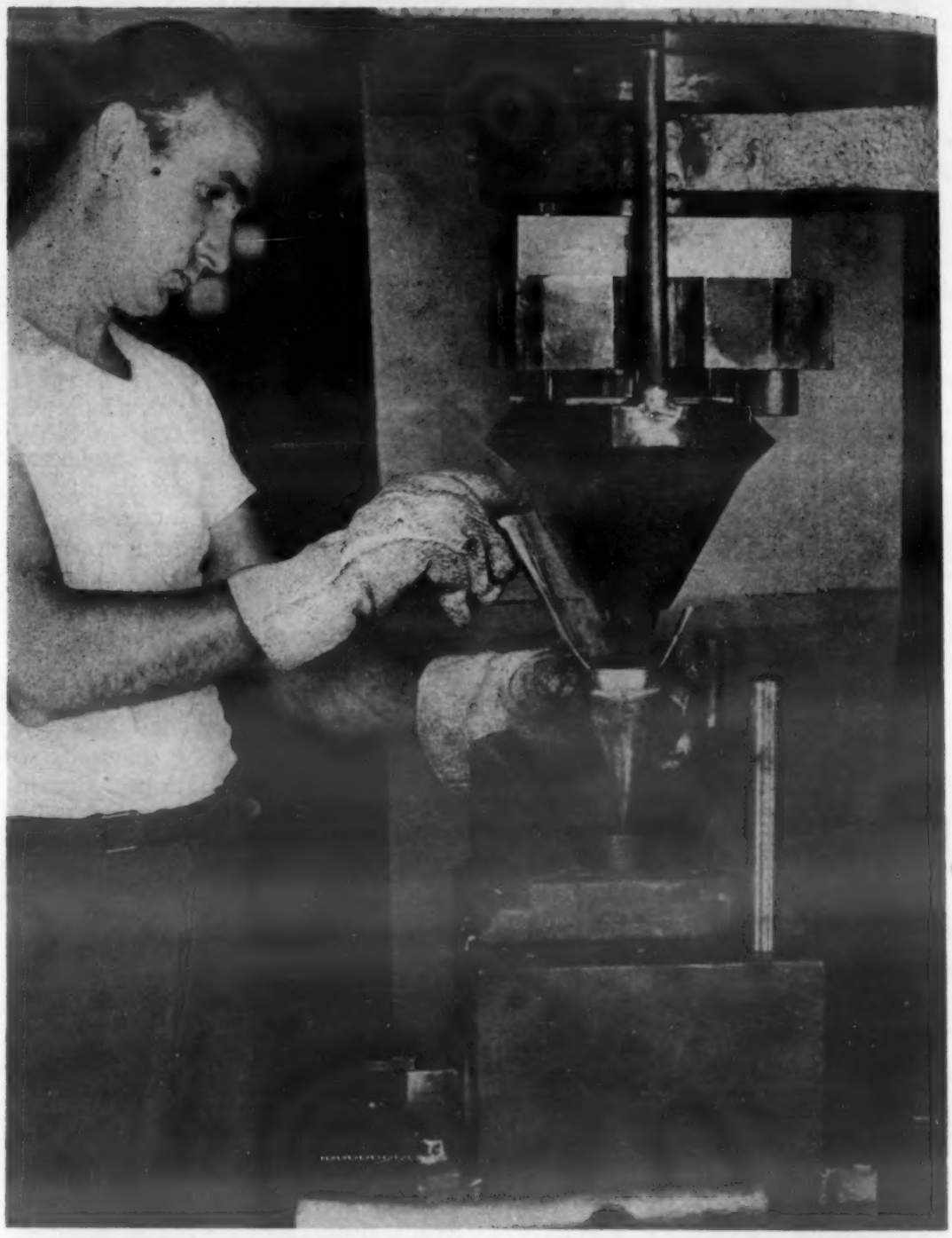
Comparison of Nominal and True Stresses and Strains in Tension Testing

% Elongation in Tension	Nominal Stress	True Stress	Difference	Nominal Strain	True Strain	Difference
5	P/A_0	$1.05\ P/A_0$	$0.05\ P/A$	0.050	0.049	0.001
10	P/A_0	$1.10\ P/A_0$	$0.10\ P/A$	0.100	0.095	0.005
20	P/A_0	$1.20\ P/A_0$	$0.20\ P/A$	0.200	0.182	0.018
30	P/A_0	$1.30\ P/A_0$	$0.30\ P/A$	0.300	0.262	0.038
40	P/A_0	$1.40\ P/A_0$	$0.30\ P/A$	0.400	0.336	0.064

by T. C. DU MOND,
Editor, Materials & Methods

New Casting Process Combines Features of Other Forming Methods

Increased strength properties, improved finish, and less need for machining are some of the advantages gained in the production of ferrous and nonferrous parts by this newly developed process.



Heat and pressure are combined to produce castings by the Bacco process. During the cycle, high pressure is exerted uniformly throughout the heated die. Higher physical properties result.

● CASTING, MOLDING, forging and coining are, in effect, achieved in one operation by the newly developed Bacco process. The process, after several years of development and experimental work, is now to be more widely used by licensees of Budds Aero Casting Co., Canaan, Conn. The process can be used with most castable materials as well as some that are not so considered, including aluminum, steel, brass, bronze and copper.

Although other claims are made for the process, those of most general interest are: (1) machining can be reduced by about 60% on parts made by this method as opposed to casting; (2) materials formed by the method are given tensile and ultimate strengths about 10% higher than the same materials formed by other casting methods; (3) on most dimensions tolerances of 0.002 in. can be held. These characteristics of the process result in subsidiary advantages, not the least of which is a considerable savings in materials through the process itself as well as by making possible reductions in section thicknesses by virtue of higher strength.

Largely responsible for the increased physical properties is the dense structure attained in the metal. In addition voids, discontinuities, and porosity are reduced to a minimum.

The Bacco process is not claimed to be or considered a cure-all for casting problems, nor an all-out competitor of existing forming methods. Its chief field of application lies among parts where considerable machining is required as now produced.

In action as well as effect, this new forming method combines features of

several other methods. For example, the metal is melted in a gas-fired furnace, then poured by ladle into a metal die. The die is heated to a temperature near that of the metal being poured. Constant pressure is exerted on the die while the metal sets, but early in the cycle, extra pressure is placed on the die to obtain a forging action.

Because of the use of pressure during the period when the metal is setting-up in the die, gases are forced out of the metal, largely eliminating the shrinkage problem. Without the need for making allowances for shrinkage, the dies can be made to final dimensions with rather close tolerances being attained on the finished part. In most cases impurities in the metal being formed are forced out of the die when the high pressure is applied.

Surfaces of parts produced by the Bacco process are extremely smooth as they come from the dies. Aluminum parts so produced appear upon examination to be almost as smooth as if buffed. The process developers state that parts have been plated with satisfactory results without any preparation other than cleaning. Steel parts made by the Bacco method are said to take on surfaces superior to those attained on nonferrous parts.

Materials Used

Since many of the parts produced in the Bacco development shops have been for armament and military aircraft programs, aluminum has been worked with extensively. Production parts tested and accepted for military use have all shown physical properties well above the specifications for the particular alloy used. In certain cases, wrought alloys have been melted and cast with the same result, namely an increase in physical properties.

Aluminum alloys most frequently used are 356, an alloy recommended principally for sand and permanent mold castings; 195, a sand casting alloy; 14ST, a wrought alloy; and 4110, a special casting alloy.

The 356 alloy has a specified typical tensile strength of 33,000 psi., and elongation of 3%. Test results on pieces formed by the Bacco process show tensile values ranging from 33,000 psi. to 41,150 psi. and elongation values of from 4.7% up as high as 9.4%. Similar results are shown with 4110 alloy. In this case typical tensile strength is specified as 33,000 psi. and elongation between 3 and 3.5%. Bacco process parts tested from 33,310 to 44,446 psi. and elongation ranged from 6.3% to 10%.

In aluminum alloy 195, tensile strength was increased from 28,500 psi. up to as high as 36,650, with elongation holding at the specified 3% or dropping slightly to 2.5%.

Alloy 14ST, taken in its wrought form, was melted down and cast, a supposed impossibility. The wrought material showed 65,000 psi. tensile strength, 10% elongation and 125 Brinell hardness. Cast by the Bacco process, the tensile strength was increased to 66,450 psi., hardness to 130 Brinell, but elongation decreased from 10% to 8%.

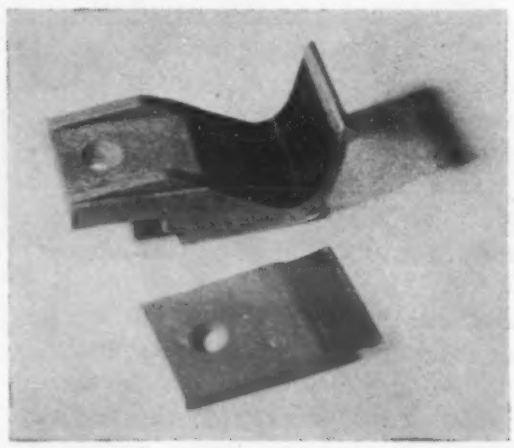
Several different bronzes and brasses have been cast with increased properties similar to those achieved in aluminum. In one alloy an increase of 14% in elongation was achieved. In another the tensile strength was raised from 18,995 psi. to 28,165 psi.

Although steels have been cast less than other materials, developers of the Bacco process are confident of its value in forming steel. Thus far 1081 and 1043 steels have been cast, with an average increase in properties of about 10%. The finish of steel parts is said to be even better than that attained with aluminum. The smoothness is limited only by the finish of the die in which it is formed.

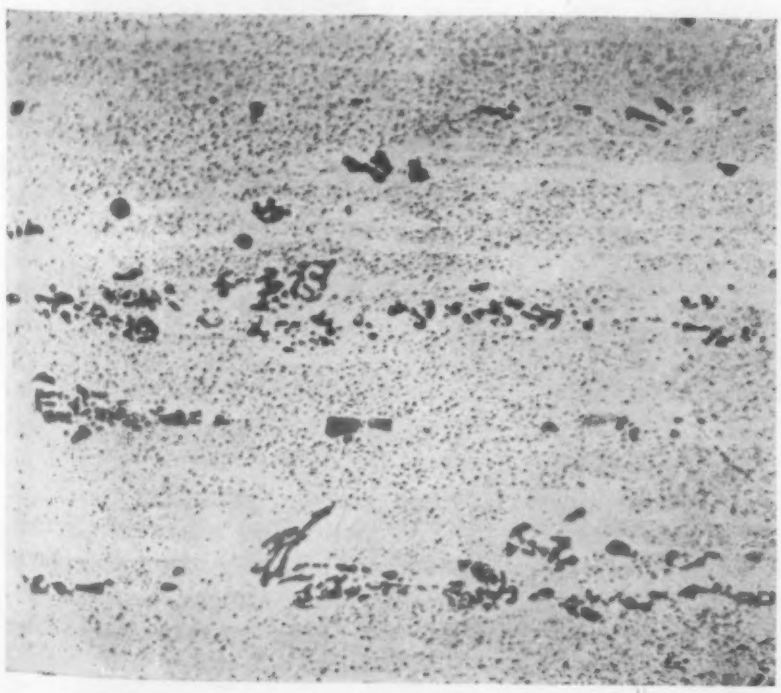
Where the Process Fits

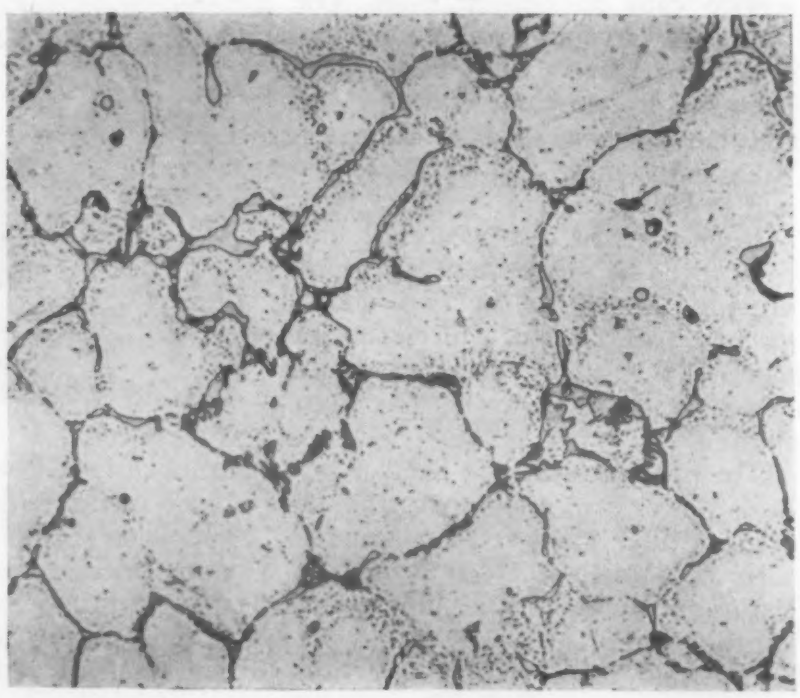
At this writing, it is too soon to determine exactly where the Bacco process will best serve. However, some of the parts already produced and in service give a good indication of suitable applications. As stated

More than 30 steel inserts are cast into these aluminum parts, intended for textile machinery.



Shown here is the apparent difference in aluminum meeting the specifications of 14ST. The photo at left shows the material in its wrought form, while the other shows the same alloy in cast form. The cast material is relatively free of intermetallic compounds. (Magnification 500X, 1% hydrofluoric etch)





previously, the Bacco process does not compete in making simple forms produced by other methods. It is expected to serve best where parts require lightness and high strength, where considerable machining would be required on parts made by other methods, or where it is important to save materials.

A few examples of parts which have been produced will serve to show the type of application that seems ideal.

One part which has proved itself is the lens mount of a special motion picture camera. As produced by other methods, approximately 23 machining operations were required to provide all of the necessary bosses and openings. Through the Bacco method a part is turned out that requires only three simple machining steps. The total weight is also reduced and, at the same time, strength has been increased.

In the case of a cast iron car door gear with teeth on the outer periphery and on one face, even greater savings have been effected. Previously, the cast iron blank required that all teeth be cut. Now, all gear teeth on both surfaces are cast in and the only machining required is the cutting of a groove between the two rows of teeth. Again, weight was reduced appreciably.

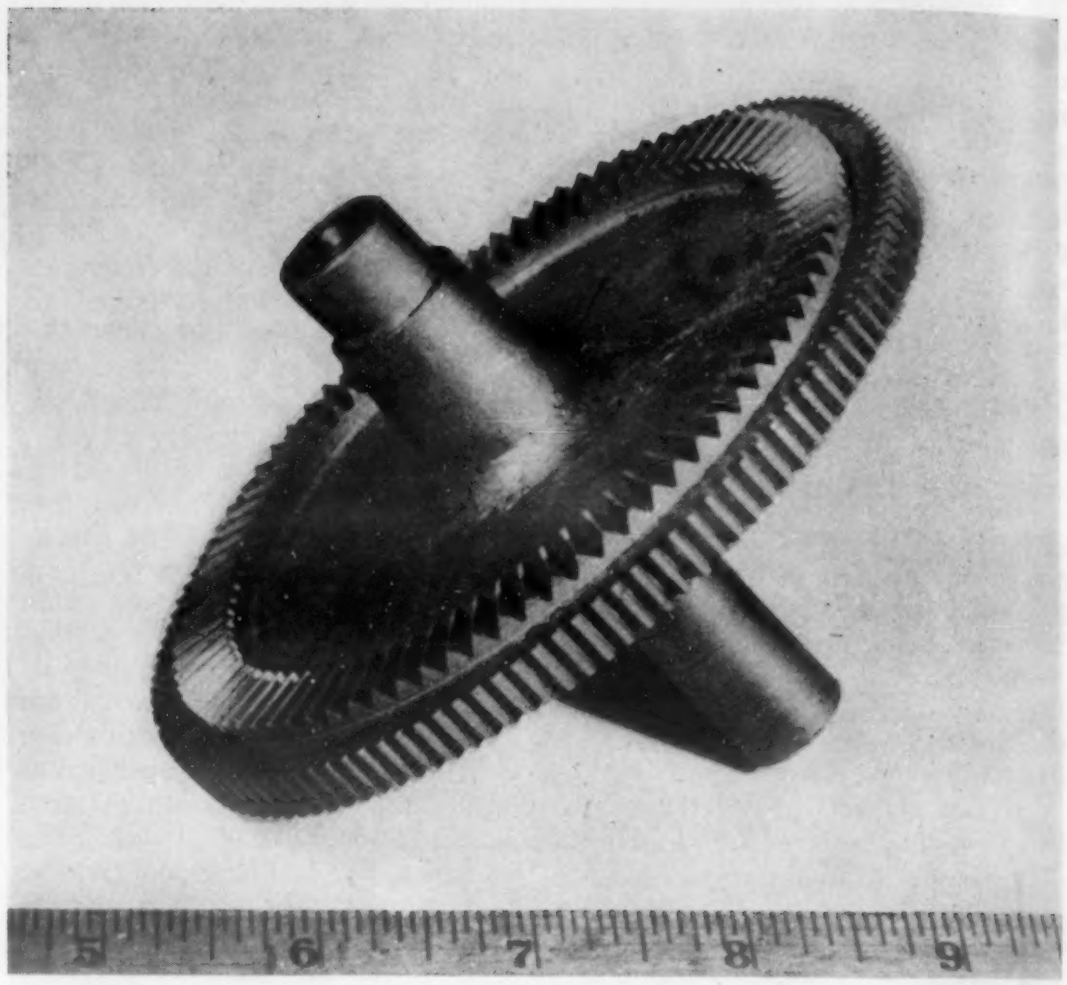
One of the smallest parts made thus far is a tripping finger of business machines. The part is approximately ⅜ in. in its largest dimension. Because of holes through two centers of the part and a groove for tightening when attached, stresses developed in service which caused the parts to break. Use of the Bacco process to produce the parts increased their purchased cost, but this was more than offset by enormous reductions in service calls to replace parts. The parts are produced in a multiple cavity die, 18 at a time. More could be made at one time if desired. In addition to being stronger than previous parts, those cast by Bacco are said to be stress-free.

Inserts can be cast accurately into parts made by this process. This type of work is typified by two textile machine parts, each of which requires more than 30 rigidly held and evenly spaced steel parts to be cast into aluminum.

The time cycle for the Bacco process is slower than mold die casting or sand casting. However, on suitable parts economies still can be shown because of savings in machining and finishing time.

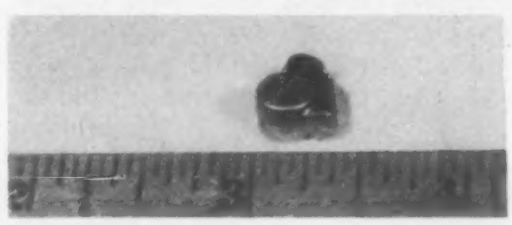
Although there will be practical limits to the size of parts made by Bacco methods, theoretically the only limitation is the size of the press used. Since rather high pressures are applied during the solidification part of the forming cycle, the press must be sufficiently large to provide the pressures.

Parts already produced by Bacco methods are being used for aircraft, typewriters and recording machines, hydraulic jacks, athletic supplies, superchargers and pressurizing units, among others.

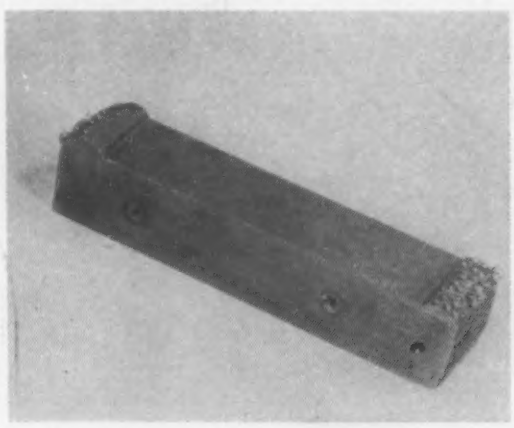


All of the teeth are cast into this aluminum gear, the only machining necessary being the cutting of the groove between the rows of teeth.

This part, for office equipment, is about ⅜ in. long on its greatest dimension.



Evenness of pressure during solidification of the metal is demonstrated by this section of a piece into which there has been cast an electrical element.



The finish on this aluminum part is exactly as it comes from the die when produced by the Bacco process.

Vitreous Enameling Broadens Scope of Aluminum Applications

New low temperature porcelain coating for aluminum alloys has excellent service properties and is available in many colors.

by **N. BRUCE BAGGER**, Associate Editor, Materials & Methods

Quick freeze units are typical of the many potential uses for vitreous enameled aluminum in the appliance field.

• THE DEVELOPMENT OF a satisfactory vitreous enamel for aluminum and its alloys has been long-awaited for many varied applications, no such finish having been available up to now for this versatile engineering metal. The Electrochemical Department of E. I. du Pont de Nemours, however, has recently produced a frit-based enamel that is fired on aluminum strips, sheetings and castings in furnaces much the same as those used for the vitreous coating of steel but at considerably lower temperatures. Unlike the steel coatings, the new aluminum finishes have the advantage of superior impact and flex resistance, excellent resistance to thermal shock, and will not develop unsightly rust if accidentally chipped or cracked. The enameled aluminum can be cut and, to a limited extent, bent or formed after firing and is unusually resistant to the action of mild acids. A very wide range of colors can be achieved by altering the formulation of the vitreous coatings.

The frits used in these coatings are highly alkaline and contain a high percentage of lead. Because of this fact, the new enamels are unsuitable for articles that are likely to come into contact with food. Widespread use of the enameled aluminum, however, is expected in such applications as storefront panels, advertising displays, sanitary ware and accessories, washing machine tubs and agitators, architectural tile, outdoor furniture, and the like.

At the present stage of development, only 2S, 3S, 52S and 61S wrought alloys and non-porous castings of 43 alloy are recommended for vitreous enameling. It is expected that additional research will lead to the satisfactory application of the enamels to other aluminum alloys.

Cleaning and Pretreatments

In general, any surface that can be easily reached with a spray gun can be enameled. Thin non-rigid sections must usually be enameled on both sides to prevent warpage, and sharp corners or edges should be avoided to prevent excessive drip, tearing, or sag in the finished coat. Appearance of the properly finished article will depend principally on good metal stock. In the case of castings, it is absolutely essential that they be substantially free of porosity. Porosity in the metal, communicating with the surface, results in pinholes and minute spall marks in the enamel coating. Successful enameling also has been accomplished over welded seams joined with 1100 F Airco rod.

In all methods of fabrication, the metal stock should not be anodized or previously treated by strong corrosion-inhibitors or cleaners. Experience had shown that proper metal cleaning to assure a clean, active surface free of grease, oil and oxide is necessary to make the surface pretreatment and enameling that follows fully effective. Since the recommended pretreating bath is not a cleaner, the metal is first immersed in a water solution of ¼% "Duponal" and 6% sulfuric acid or equivalent. Solvent vapor degreasing can be used on bright sheet stock that is not heavily oxidized. After cleaning, the work is thoroughly rinsed and dried.

The pretreatment necessary for a good enamel bond is achieved by immersing the work in a hot water solution of 0.2% chromic acid, 19% potassium chromate, and 3.8% sodium hydroxide by weight. Immersion times and temperatures vary according to the alloy being treated. Both the bath and the pretreated stock should be handled with due regard to the caustic and chromate contents of the solution. Following immersion in the pretreating bath, the work should be promptly rinsed in clear water to stop chemical action, and then thoroughly washed.

Under-treatment may result in enamel spalling in use. Over-treatment causes excessive corrosion of metal, leaving a thick film of corrosion products which are not penetrated by the enamel. In moderate cases of over-treatment, stock can be enameled satisfactorily if this film of loose corrosion products is brushed off after prefiring. When over-treated or insufficiently-washed metal is enameled, the ground coat frequently spalls off on cooling or when the cover coat is sprayed. Such over-treatment prevents the ground coat from thoroughly wetting the base metal during firing.

Applying Enamel and Firing

Following pretreatment, the stock is prefired to a temperature of 970 to 1000 F for a minimum period of 5 min. for small charges of thin section. Upon cooling to room temperature, the prefired stock is sprayed with a thin coat of smooth, wet slip. In this operation, excess slip should be avoided, particularly in corners. The proper quantity of spray application can be judged by weighing the piece before spraying and after drying. From 15 to 20 gm. per sq. ft. are usually recommended for ground coat applications.

After spraying, the stock should be dried to prevent dust pick-up. Low temperature drying is desirable, since high temperature drying or excessive drying time may result in tearing. Usually, drying need be continued only to the point where surface moisture disappears.

Dried articles, well-supported on a suitable rack, are then fired under conditions the same as those for the prefiring operation. In production furnaces, firing conditions will depend on load in furnace, thickness of metal sections, locations of pyrometers, and other factors. Care must be exercised to avoid too high a temperature to prevent excessive metal deformation. Too low a temperature or too short firing time, or both, will result in an inadequately bonded ground coat. This defect shows up by spalling on cooling or spalling during application of cover-coat slip. It should also be noted that such failure can result from over-treatment of the metal prior to enameling. Refiring at higher temperatures or for a longer period generally corrects underfiring. As the purpose of the ground coat is merely to bond cover coats to stock, a thin application is adequate.

After cooling ground-coated stock to room temperature, the cover coat is applied by spraying. It is essential that the ground-coated surface be kept free of grease, oil or dirt on articles to be enameled in bright colors, as organic material will burn under firing and leave dark carbon marks. One such coat will usually suffice and can be applied to the necessary thickness, again avoiding excess in so far as possible in corners. The total deposit of ground and color coats should be from 40 to 70 gm. of enamel solids per sq. ft. Should difficulty be encountered with tearing, it can usually be overcome by applying two lighter cover coats, each separately fired.

The cover coat is fired under conditions similar to those for the standard ground coat, *i.e.* about 970 F. Over-firing may result in failure in the accelerated spalling test, and for this reason should be avoided where at all possible. It should also be noted that the thickness of the cover coat and the firing conditions can affect in some degree the ultimate color obtained.

To achieve multiple-color cover coat effects, a cover coat of one color is first sprayed and fired on the standard ground coat. Upon this cover coat, other colors can be sprayed and fired, masking or wipe-off techniques being used to obtain desired patterns or designs prior to the firing operation. Colored effects can also be achieved by the squeegee process, using specially prepared squeegee inks. In this, several colors, including the last overall cover coat, can be fired simultaneously.

It is not expedient to apply multiple color coats by brushing dried enamel from a sprayed coat through a stencil because, on drying, these enamels bond very firmly. As a further deterrent to this practice, lead dust hazards are also incurred which exert a decided influence on the factor of employee safety.

Commercial development of vitreous enamel for aluminum was long retarded by the spalling that occurred when test pieces were exposed to atmospheric conditions. The improved method of pretreatment discussed above appears to have corrected this earlier deficiency when judged by an accelerated spalling test. This test consists of immersing finished samples in a 5% ammonium chloride solution at room temperature. At least 6 in. of interface between enamel and metal is exposed on each piece. The specimens are examined after 24 and 96 hr., failure being judged by the loss of enamel progressing over ⅛ in. in from the edge over a ½-in. breadth. The exact amount is not critical because failure generally is very extensive or else negligible. Evidence to date shows this method of testing to be the best and quickest measure of the ability of the enamel to adhere under weathering conditions. However, time will be required to show the extent to which this test can be relied upon to indicate satisfactory life of enameled articles under conditions of actual use.

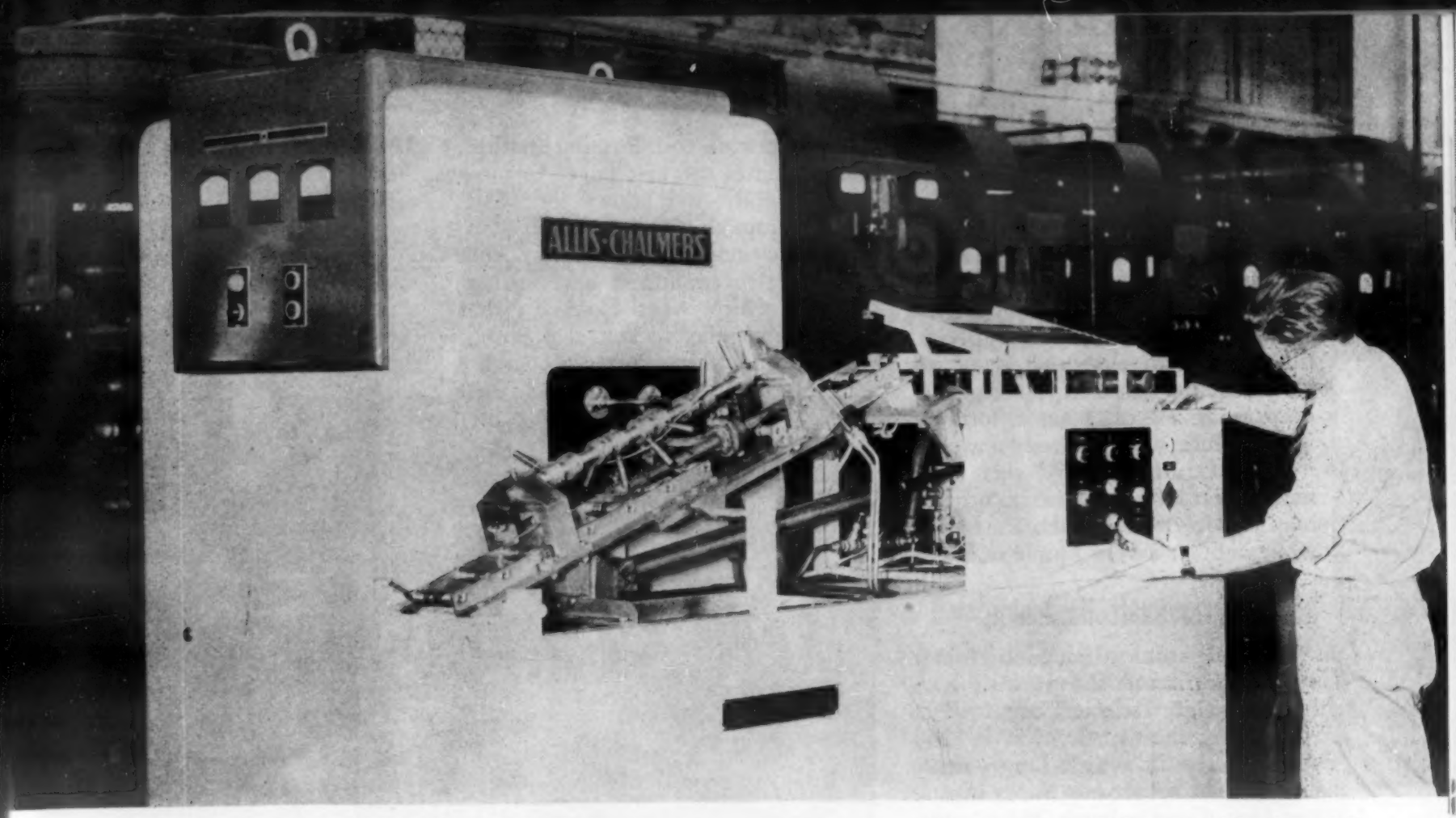


Fig. 1—This electronic induction hardening machine to harden rocker arm shafts uses a fully automatic work fixture and hardens eight areas on each shaft at the rate of one shaft per min.

Production Economies Realized by Proper Use of Induction Heating

by J. A. EVANS, Allis-Chalmers Manufacturing Co.

The case histories given here demonstrate the versatility of induction heating and how its carefully planned use results in better and lower cost heat treating and brazing.

• WHEN A NEW PRODUCT is to be developed it is just as essential to consider materials and production methods as product design, and the three should be worked out together as a unit. With new materials and methods of production being developed, it is possible in many cases to effect design changes to lower production costs. It is in keeping with this trend that the induction heater with its versatile method of processing metal parts has been so great a help to industry.

Induction heating can be applied to ferrous (magnetic) and nonferrous (nonmagnetic) metals. In the former, heat is induced into the work by means of both eddy currents and hysteresis losses, while in the latter only eddy current losses are produced. This makes it somewhat more difficult to load into nonferrous metals.

With induction heating, especially case hardening applications, there is generally a greater freedom in the choice of suitable metals for a particular job. This among a number of other reasons has brought out the usefulness of induction heating. The only critical factor of a metal with induction hardening is the carbon content. Plain carbon steels such as SAE 1045 give excellent results for a large variety of applications. However, where the specification requirements are more rigid or for other reasons, it is often desirable to use a more complex alloy.

For example, valve lifter rods must have hardened ends to withstand constant pounding. These rods can be made of plain low carbon steel whose ends have been carburized, heated in a furnace, and then water quenched to give desired hardness.

In order to avoid the excessive scale caused by furnace hardening, the rod ends can be selectively induction hardened; the carburizing process can also be eliminated by using a SAE 1045 steel. This type of steel, however, frequently requires drawing back the hardened area in hot oil to prevent overstressing or cracking of the metal. To eliminate the drawing operation, a higher alloy steel such as SAE 1165 can be used with an oil quench. The portion to be hardened is quenched slower in oil, but the higher alloy reacts better and faster.

As with any other process or method, induction heating must be

justified by resulting in lower costs, superior quality of product, improved working conditions, or a number of other reasons. Thus, a thorough investigation of the economics and performance must be made before any investment is made. The production set-ups described below are applications where an electronic induction heater has proved itself in actual production. In all cases some form of work fixture was required; however, it must be remembered that these fixtures vary from job to job. Some may require a very elaborate fixture while another a very simple one.

Rocker Arm Shaft Hardening

The electronic induction heater and work fixture shown in Fig. 1 hardens eight selected areas of a rocker arm shaft made of SAE 1045 steel for use in a well-known make automobile. At present this company has four Allis-Chalmers 20-kw. units which, in conjunction with proper work fixtures, are cutting costs and improving product quality. This particular fixture is one of the more elaborate ones and is fully automatic. The control of the complete unit is by means of pushbuttons on the control panel.

This rocker arm shaft is about 17¼ in. long, has an ID of about 17/32 in. and an OD of about 13/16 in. The particular areas to be hardened are about 1¾ in. long, contain an oil hole and slot, and are hardened to Rockwell 55C or better with a case depth of 0.020 in. The heating time is 2 sec. with a 3.5-sec. quench. The hardening operation produces no objectional scale or warpage.

Shafts to be hardened are placed on the inclined rack just above the control panel and the completed shafts slide off the incline to the left into a work bin. When only three or four shafts remain to be hardened on the inclined rack, a signal is given to indicate that more shafts should be placed on the incline. No handling of the work is required during the hardening process.

In operation, the induction heater is first turned on and the fixture brought to the correct sequence of operation by means of pushbuttons. Pushing another button causes an air cylinder to reach back and pull a shaft from the bottom of the inclined rack so that it slides onto the second incline. Because the shaft with the adjustable fingers located on the work fixture has been properly set, the rocker arm shaft stops when it strikes the first finger before entering the work coil. Pushing another button causes the first finger to turn away slightly and allows the shaft to slide into the work coil and stop at the second finger. This and the following seven fingers have spring contacts which, when closed by the pressure of the rocker arm shaft, cause a multiflex timer to operate. The fingers are located so as to stop the shaft at the proper place in the work coil in order to harden each of the eight required areas.

When the contact on each of the fingers is closed, the sequence of the timer is to turn on the RF power, turn off the RF power after the heating cycle, water quench the piece

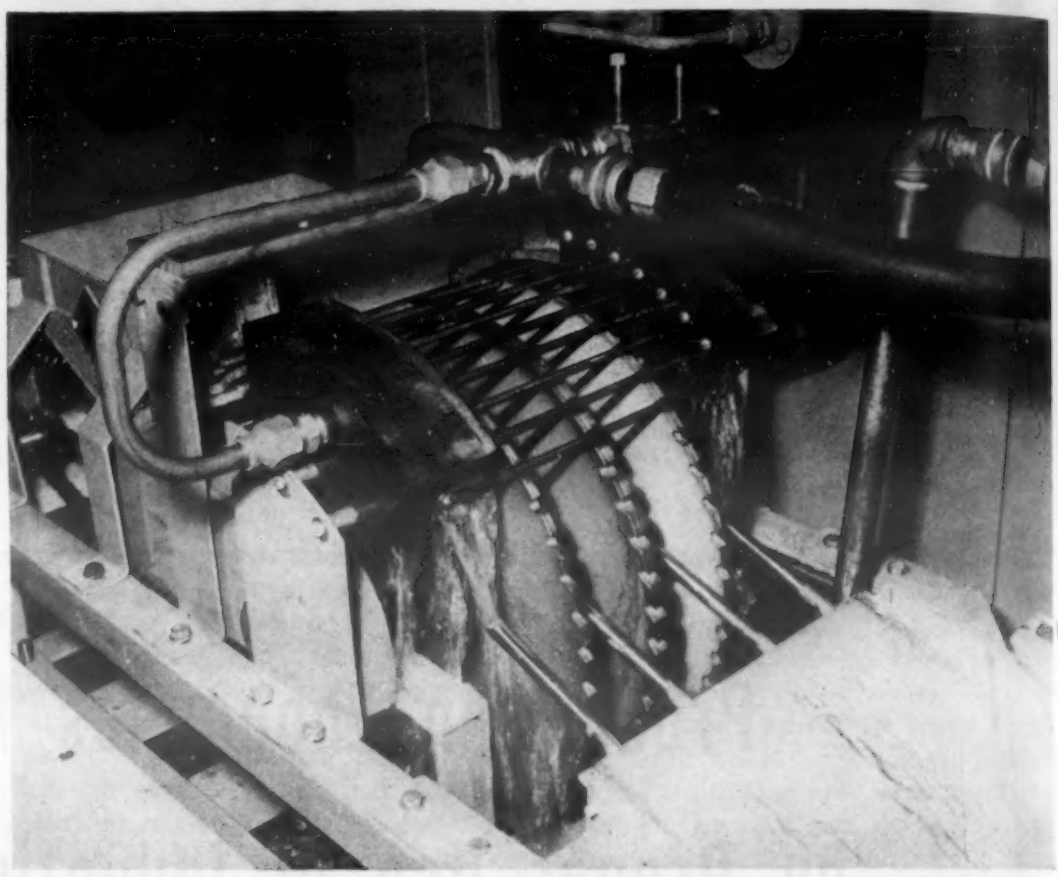


Fig. 2—Valve lifter rods are through hardened on both ends by means of this automatic fixture at a rate of 3600 per hr. The hardened area is about ⅝ in. from each end and has a hardness of 55 Rockwell C or better.

Fig. 3—A semi-automatic fixture induction anneals automobile brake arms at the rate of 2400 per. hr. The section annealed is that shown beneath the right hand of the operator as he loads the fixture.

Fig. 4—An electronic induction heater anneals the splined bore of transmission gears prior to the broaching operation. The RF switch increases production by performing the annealing operation on one side of the switch while the other side is being unloaded and reloaded.

Fig. 5—A soldering application of oil gages on a production line basis. Induction soldering and brazing has greatly improved both quality and quantity of many applications.

immediately after RF power is off, turn quench water off after the quenching cycle. The finger then turns slightly to allow the shaft to slide down the incline so as to strike the contact of the next finger. After all eight areas have been hardened, and the last finger has turned away allowing the shaft to slide off the incline, the air cylinder reaches back for another shaft. This next shaft slides into the work coil stopping at the second finger and repeats the eight hardening operations automatically. The production rate is about 60 shafts per hr.

Synchronized Hardening Process

Fig. 2 shows a fully automatic unit for through hardening the two ends of valve lifter rods. These rods are hardened at the rate of about 3,600 an hr., and require no handling other than placing the rods in a bin and removing the hardened rods from another bin. The rods are about 9¼ in. long, about ¼ in. in dia. The ends are through hardened from ½ to ¾ in. from each end. The hardness of the cold drawn SAE 1045 steel averages better than 55 Rockwell C for this application.

The valve lifter rods are first placed in a bin on one end of the fixture which has an opening on the side at the bottom so that the rods can be picked up by the notches on the drum as it turns. The rods are picked up one at a time as shown and are carried through the work coil so as to through heat the ends. They are then passed progressively through the quench block. As the drum continues to turn, the rods drop off the drum and fall into another bin. The quench media is water and the rods are drawn back in hot oil within ½ hr. after they are quenched. A variable speed drive can adjust the speed of operation of the drum. An alloy such as SAE 1165 can be used with an oil quench, which eliminates the necessity for drawing back the rods.

Hardening Brake Arms

Fig. 3 shows a semi-automatic work fixture for annealing automotive brake arms made from a low plain carbon steel. The section to be annealed is shown just beneath the right hand of the operator as he inserts a piece into the rotating fixture. As the table rotates the bottom portion of the piece is carried through the work coil. This work coil connected to the electronic induction heater brings the desired portion up

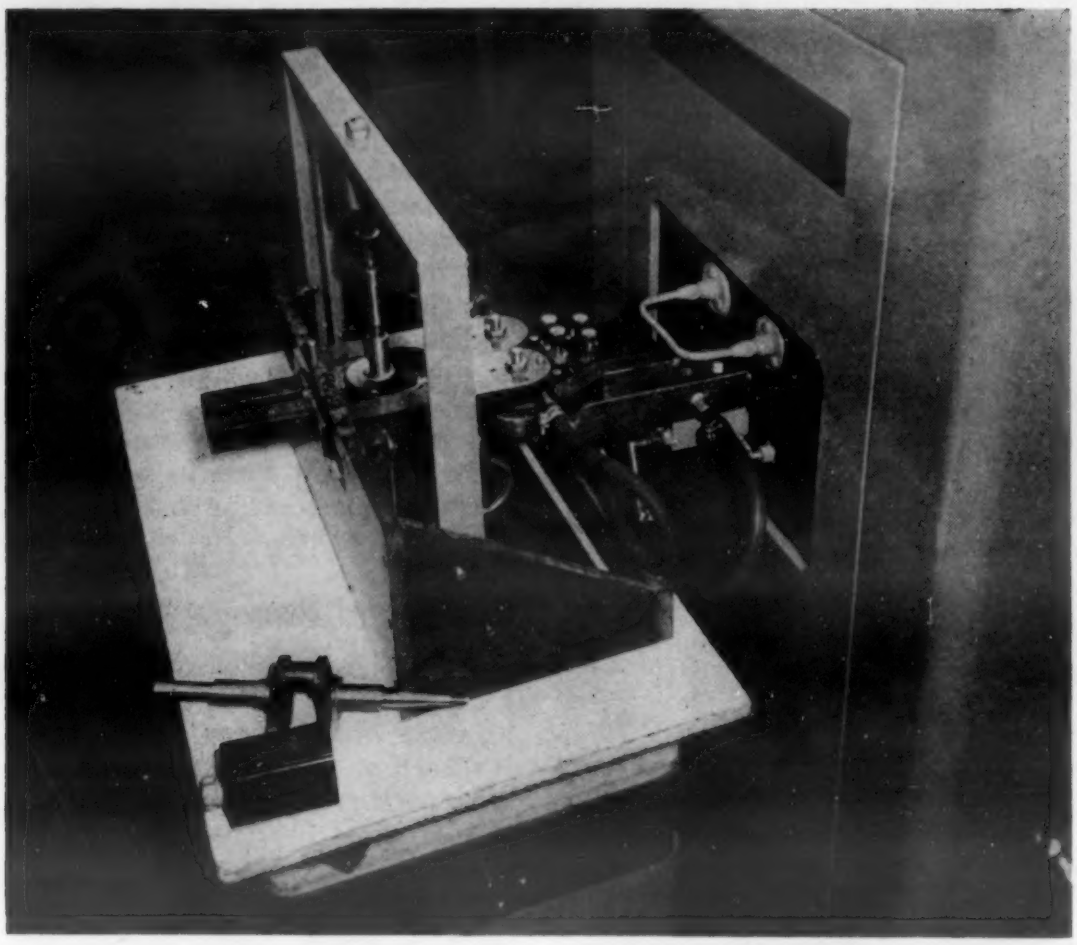


Fig. 6—A clamp-type coil to case harden crankshaft and camshaft bearing surfaces.

to annealing temperature. As the piece reaches the slide which is directed into the tote bin, the piece is released and slides into the bin as shown.

The 20-kw. heater anneals about 2,400 pieces per hr., and all the operator has to do is load the pieces into the fixture. Only the desired portion is heated, and there is no objectionable heat to bother the operator.

Annealing Internal Splines

A semi-automatic work fixture to anneal the internal spline of transmission gears prior to a final broaching operation is shown in Fig. 4. This fixture makes use of what is called an RF switch, which can be used on a number of similar adaptations. The sequence of operation is such that while one gear is going through its annealing operation, the operator can prepare a second gear for its heat cycle.

After the induction heater is turned on and ready to heat, the operator positions the first gear on one of the supports. The foot pedal operating this support is pressed and the support is raised up to the coil by means of an air cylinder. As the work coil enters the gear a micro switch turns on the RF power when the gear comes to the end of its travel. While this first gear is being annealed a second gear is placed on the second support. When the preset timer times out, the RF power is turned off and the gear support is lowered. By this time the operator has positioned the second gear and is ready for a repeat operation.

The internal annealing has no effect on the hardness of the external gear teeth. The fixture is built so as to rotate the gear during the time it is in the raised position, resulting in a more uniform heat pattern. A considerable saving was realized from this induction annealing operation. It is also possible through the use of an RF switch to perform two separate operations, one after the other, without changing any work coils. That is, two different size gears can be annealed, or one piece can be hardened on one coil and the second coil can perform a brazing operation, etc. This feature adds to the versatility of the electronic heater unit.

Soldering and Brazing Uses

Fig. 5 shows a work fixture with an electronic induction heater used in soft soldering oil gages. The oil gage is carried past the work coil by means of the conveyor system, and a brass diaphragm is soldered onto the inside at the bottom of a sheet metal stamping. The soldering operation gives a bond which makes a perfect seal without any excess solder material flowing onto the diaphragm. The production rate is about 1,800 gages per hr. A hood above the fixture carries away any fumes caused by heating the flux.

It can readily be understood that there is a large variety of soldering applications, and the same can be said for brazing. Not all, but many of them can be done effectively and efficiently by induction heating. An example of this is the brazing of a plug into the end of an hydraulic jack cylinder. The internal surface of the cylinder is honed, before brazing, up to the edge of the bonded joint of the plug. The specification allowed discoloration of the honed surface ½ in. from the plug; with electronic induction heating no discoloration extended beyond 1/16 in. from the plug in spite of the fact that brazing material could be seen from 90 to 100% around both sides of the joint. The results were especially good considering the fact that the brazing material flowed about 5/16 in. from the center to each side of the plug.

Fig. 6 shows a hand operated work coil and fixture for hardening crankshaft bearing surfaces. The application shown is a single throw crankshaft whose pin is 1⅛ in. long and ⅞ in. in dia. The desired case depth is between 0.035 and 0.050 in., with a 50 to 55 Rockwell C hardness when a SAE 1340 steel is used. The heating time with a 20-kw. electronic induction heater is 15 sec. per crank pin with an extra 10 sec. for quenching.

This split type inductor with automatic quench was designed and built by Allis-Chalmers Manufacturing Co. to improve the method of hardening crank pins and cam shafts by means of induction heat. The fixture shown is hand operated; however, other fixtures are available with clamping devices and interlocks both manual and automatic. The size of the crank pin will, of course, determine the size of the inductor, duration of heat cycle, and output capacity of the induction heater.

The advantages of this method are rapid heating, minimum distortion, no objectionable scale, better working conditions, less handling, and an improved product. The type of steel used can vary from plain carbon steels to the more expensive alloys, depending upon the required specifications. The quenching media must also conform to the requirements, but water is generally used for this purpose.

How to Select Materials for Plastic Mold Cavities

by L. J. MORRISON, Detroit Mold Engineering Co.

A wide variety of mold materials is now available, and choosing the most economical one for a given application requires careful evaluation of the many factors involved.

• SO MANY DIFFERENT materials are used for plastic mold cavities that the uninitiated engineer is likely to be confused. For there is little specific agreement among molders, mold makers and steel manufacturers as to the proper selection of cavity materials. Each molder or mold maker has his own preference; he knows how it machines and polishes, and how it responds to heat treatment. To deviate from this preference is to risk considerable loss and questionable gain. Apparently the steel manufacturers have little to suggest in the way of steels designed specifically for molds. Surveys made by our company indicate that, as a whole, the steel makers are not too well informed on the problems of molders and die makers. It is natural, then, that the consumer should rely largely on his own experience and judgment.

It is the purpose of this article to discuss briefly the advantages and limitations of the various types of materials (mostly steels) used for plastic mold cavities, and to indicate the factors to be considered in selecting the proper material for a specified set of molding conditions. In order to give a more complete picture of the materials problem in plastic mold design, a short outline of the materials used for other parts of the mold has been included.

First we should establish some criteria by which to judge materials for mold cavities. From the standpoint of mold manufacturers, steel used for mold cavities should machine freely, or hob easily under low tonnage, depending upon the forming method used. Both types should take a high polish and suffer minimum distortion when hardened. The steel must be clean — free from impurities such as sulfides, segregation or porosity.

From the molders' standpoint, the steel should have high surface hardness after hardening and high core strength. For some sections, high tensile strength may be essential. With these dual qualifications in mind, let us consider the various materials used for cavities.

Steels generally used for machined plastic molds include alloy carburizing oil-hardening, air-hardening and stainless types. Cavities made by the hobbing process present additional problems to the steel maker. In order to make steel as workable as possible for best hobbing conditions, the carbon content is lowered and all alloys are removed. The resulting cavity can be hardened only by carburizing, and then the core remains soft. Steels other than the plain low carbon variety can be and are hobbed, but

Steels used for mold cavities should machine freely and take a high polish. (Courtesy Fuller Brush Co.)

only at the expense of additional hobbing pressures.

Machine steel, otherwise known as SAE 1020, was one of the earliest cavity materials. It was universally obtainable, cheap and easy to machine, and so found widespread use. In addition to having low strength and hardenability, however, this steel is not as clean and does not polish as well as alloy types. Also, distortion in heat treating is a maximum in this steel. For these reasons SAE 1020 has been largely supplanted by alloy steels for mold cavities.

Alloy Carburizing Steels

The alloy carburizing steels represent 60 to 70% of the tonnage used in plastic molds. SAE 4615, 3120, 3312, 4130 and many other analyses fall in this category. All have the common fault of dimensional change as a result of carburizing, but this can be minimized by careful heat treating.

SAE 4615 is a molybdenum steel containing 1.65 to 2.00% nickel and 0.20 to 0.30% molybdenum. These alloys serve not only to toughen the steel but also to improve the carburizing properties, as they increase the rate of carbon pick-up at the surface. A core hardness of 280 Bhn. can be expected after heat treatment. In the annealed condition, machining and benching properties are excellent. The electric furnace variety is preferable.

SAE 3120 is a typical chromium-nickel mold steel. Addition of chromium improves hardenability and polishing properties. Core strength runs as high as 130,000 psi. It is somewhat more difficult to machine than SAE 4615.

SAE 3312 is a chromium-nickel steel, with nickel content raised to 3.5% and chromium to 1.5%. This steel can be hardened in air after carburizing and, therefore, distortion due to heat treatment can be minimized. Core strength of 160,000 psi. and hardness of 360 Bhn. are obtainable. Machining and benching are considerably more difficult than on the steels previously mentioned. All air-hardening steels have the further disadvantage of requiring careful annealing after welding in case of repair.

SAE 4130 (chromium-molybdenum) types are very popular as carburizing mold steels. This composition is 0.30 carbon (high compared to most carburizing mold steels), 0.65 chromium and 0.20% molybdenum. Although tensile strength and hardness are high, toughness and dimensional stability are not as good as in the SAE 3312 type.

Oil-Hardening Steels

Water hardening steels are seldom used for cavities. The drastic quench necessary in heat treatment makes the steel too susceptible to cracking, and distortion is a maximum. A great variety of oil-hardening steels are used, however. It is not practical to discuss here all the steels recommended, for nearly every molder and mold maker has his own idea of the best. Nevertheless, there are several types of oil-hardening steels which are widely used and are representative of the field.

Steels similar to SAE 1090, but with higher manganese content, have been used on small- and medium-sized cavities with varying success. However, alloy types have been used more generally because of better toughness and finish.

SAE 6150, a chromium-vanadium steel, is quite popular. Medium carbon content (0.50%) and 1% chromium combine to make an extremely tough steel. The vanadium (0.18%) produces fine grain. Oil quenched, the steel hardens to about 50 Rockwell C, considered low by many molders. Stability in heat treatment, machinability, and finishing properties are all good.

A general-purpose oil-hardening steel made by many companies has the following composition: 0.90 carbon, 1.25 manganese, 0.50 chromium, and 0.50% tungsten. Although its machinability is good, increased carbon makes this steel somewhat more difficult to machine than SAE 6150. The oil-quenched steel hardens to 60 Rockwell C and has good strength. Heat treatment of large uneven sections is generally not advised.

Air-Hardening Steels

The physical properties of some of the air-hardening steels make them probably best of all for cavity work. Known as "hot work" die steels, they are characterized by medium carbon content (0.35 to 0.45%), 4.0 to 5.0% chromium and varying smaller percentages of molybdenum, silicon, vanadium and tungsten. They have maximum core strength and toughness, and surface hardness up to 58 Rockwell C. The polish attainable is second only to that on stainless steel. Distortion in heat treatment is a minimum for there is no size change due to drastic quench or absorption of carbon as in carburizing. On the other side of the ledger, the hot work steels are among the toughest to machine and bench. Compared to the steels already mentioned, the cost per pound is also quite high.

For cavities for injection molds it is questionable if steel of this quality is necessary, but, for cavities and punches for compression molds, the best is often none too good. Long cores and cavity sections subject to high transverse stresses are best made of hot work steel.

High carbon-high chromium air-hardening steels are seldom seen in cavities but find use in hobs where their high compressive strength is advantageous. They do not have the toughness and resistance to transverse stress shown by the hot work steels.

Stainless Steels

When it is necessary to have the best polish possible, as in molds for lenses or fine jewelry, use of stainless steel is indicated. For this work, a type containing 0.30 carbon and 13.0% chromium is widely used. It is considered quite difficult to machine and polish. Free-machining grades are made by the addition of sulfur, but the high sulfur produces a "dirty" steel which will not polish to the perfection usually required of stainless steels.

Alloy Hobbing Steels

SAE 3110, containing 0.10 carbon, 0.50 manganese, 0.60 chromium and 1.25% nickel, is typical of the alloy hobbing steels. Its core strength is about two to three times that of plain carbon hobbing steel. Its machinability is just fair.

For master hobs, two types of steel are very popular: tungsten chisel and high carbon-high chromium. Tungsten chisel steel is probably the more widely used. It contains 0.50 carbon, 0.20 manganese, 0.75 silicon, 1.20 chromium, 2.50 tungsten and 0.25% vanadium. Pack hardening in charcoal followed by an oil quench produces a very hard skin (61 to 63 Rockwell C) and a tough core. This steel is especially resistant to transverse stresses due to irregularities of shape, one of the main causes of hob breakage.

High carbon — high chromium steels are used for hobs because of their extremely high compressive strength and their dimensional stability during heat treatment. Their resistance to transverse stresses is low.

Recent Developments in Cavity Steels

Recent developments in cavity steels have been confined principally to hobbing steels, the goals being improved machinability, increased core strength, and better dimensional stability during heat treatment. One company has been investigating an oil-hardening graphitic steel. Another has developed a 0.90% carbon steel that will give a deep case and hard core in carburizing. Tests have shown that both of these steels can be hobbed, but the pressure required is somewhat greater than that required by SAE 3110.

Most interesting advance is an air-hardening hobbing steel developed separately by Westinghouse Electric, Carpenter Steel, Crucible Steel and Bethlehem Steel. The analysis runs about 0.10 carbon, 0.37 manganese, 5.0 chromium, 1.0 molybdenum and 0.35% vanadium. This steel is more easily machined than ordinary hobbing steels but does not work harden as rapidly. It is hardened with low deformation by carburizing and air quenching; the resulting surface hardness is 57 Rockwell C and core hardness 25 Rockwell C. Preliminary results obtained from use of this steel indicate that it may be the closest yet to a universal mold steel for the plastics industry.

Other Cavity Materials

Materials other than steel are often used in cavities. Electro-formed cavities, made by plating iron on a rubber master, are occasionally used to reproduce extremely intricate work that is not too deep. However, the problem of backing up the plated cavities has not been satisfactorily solved and the long period of time—usually several weeks — necessary for the plating is objectionable. Plated cavities are of use principally for injection molds. Cavities made by spraying molten alloy steel on a revolving water-cooled master have been tried, but the process is still in the experimental stage.

Beryllium copper has great potentialities as a cavity material. It will reproduce the finish of the master it is cast upon, and it can be hardened to 40 Rockwell C. It is quite tough and does not tend to chip or crack. New alloys that will harden to 50 Rockwell C are being developed. However, much work has yet to be done on casting technique and materials handling. Beryllium copper is used mainly in cavities for injection molds, seldom for compression.

Selecting the proper steel for the large mold used in producing this part requires the weighing of many factors. (Courtesy Hydraulic Press Manufacturing Co.)

Selection of Cavity Materials

Selection of a particular type of material from the group enumerated now becomes largely a matter of economics. If the cavity can be hobbed, the choice is restricted to hobbing steels. Because of their superior core strength, the alloy type hobbing steels are to be recommended if the hobbing shop feels it can handle them; otherwise, the plain carbon types must be used and there is little choice.

If production requirements are such that the mold must be run to destruction, the best materials should be used regardless of cost or ease of machining. In case of annual design changes, less durable materials can be used. On long run jobs of intricate shape, it is frequently cheaper to use hobbed cavities or beryllium copper cavities until they are no longer serviceable; replacement of these cavities is usually inexpensive.

When dimensional accuracy is of paramount importance, the air-hardening or hot work types are best because of their low dimensional change during heat treatment. For extremely large sections, carburizing types are favored because there is less danger of cracking in heat treatment.

Selection of materials for the balance of the mold does not present the problems involved in choosing cavity materials. Cleanliness and high polish are of little importance, and dimensional changes occurring in hardening treatments can be compensated for and corrected by grinding. In addition, there is none of the hand work which complicates cavity manufacture.

Transfer pots and punches require hard surfaces and high core strengths. Good oil-hardening steels or the alloy carburizing steels are commonly used. Cams for core pulls and moving parts of the mold are usually of an oil-hardening grade. Oil-hardening or hot work steels are used to prevent brittleness in machine nozzles and sprue bushings. Water- or oil-hardening steels are frequently used for backing plates.

Ejector pins are often made of carbon drill rod because this material is available in many diameters. But far better results are obtained from alloy steels such as Nitralloy, SAE 6150 or chisel steels. Tempered spring wire is an excellent material for pins ⅛ in. in dia. and smaller.

Grids or risers for compression molds are made of cast iron or steel; sometimes a welded machine steel construction is employed. Steam plates are made of machine steel or SAE 1040. The higher carbon steel is to be preferred because of its higher tensile strength. Injection molds are usually built up of machine steel, but the trend is toward a toughened steel, such as heat treated SAE 1040 or 6150.

Automatic Hard Facing Speeds Production Over Manual Methods

Where applicable, the use of submerged arc welding for hard facing will often result in lower unit costs and more uniform deposits.

by **WILLIAM PRICE**, Methods Engineer

& **C. V. FAAS**, Welding Engineer, LaPlant-Choate Manufacturing Co., Inc.

● WHEREVER LARGE quantities of parts require hard facing it is worthwhile to consider mechanizing the operation. Automatic hard facing can reduce cost per part because fewer operators are required. In addition, the hard facing is usually more uniform and the operation can be performed much more rapidly.

Engineers at LaPlant-Choate Manufacturing Co., Inc. have devised a means for automatic hard facing using a standard submerged arc welding machine. The parts being faced by this method are steel cutter bars used in earthmoving equipment.

Few pieces of equipment must withstand service conditions as severe as those to which cutter bars and teeth of earthmoving machinery are subjected. When several tons of soil and rock are to be lifted or pushed, the loading at the contact areas is high, and the force is usually applied with shock. In addition to the static and kinetic forces applied, abrasion is extremely severe. Cutter bars on bulldozers, for example, will be forced over and through sand and gravel with heavy pressure applied, and such service occurs not occasionally, but continually.

Shock loading on the bars requires that a certain amount of flexure be retained in the member so the body of the bar is of steel, and is given a spring temper. At the bottom edge of the cutter bar, which constitutes the cutting edge, a deposit of a hard-surfacing compound is laid down to provide the high resistance to abrasion needed at this part of the bar.

Hard-surfacing of steel cutter bars is an important operation at the LaPlant-Choate plant where daily production requires many such bars, in a range of lengths and thicknesses, all with a hard-faced cutting edge. The cutter bars range from 10 in. to 116 in. in length, and are made from 0.50 to 0.60% carbon steel. The hard-surfaced edge is usually about 7/8 in. wide, and laying down hundreds of inches of this facing by manual arc methods would be a tedious and time consuming operation.

Since the deposition is done along a straight line, it lends itself readily to mechanizing with the automatic equipment. Manufacturers of the hard facing rod have supplied the material as a coil of uncoated stock 3/16 in. in dia. for use with the Unionmelt machine. The hard facing wire is the standard #122 formulation of Stoody Co., and is a chromium-manganese-silicon - molybdenum - iron composition.

Hard Facing Procedure

Before hard facing, the steel that is used for the cutter bars is cut from multiple length bars to the lengths required. Cutter bars are made in a variety of sizes, ranging from 6 to 10 in. in width and from 10 to 116 in. in length, and with stock of from ½ to 1 in. thick. Flame cutting is used to cut the bar stock to the desired length. Square holes of the proper size are then punched through on a heavy punch. An indexing bar makes possible the rapid and accurate positioning of the holes by which the cutter bar will be attached to the earthmoving equipment. The holes are then countersunk on a four-spindle rail drill.

For the automatic hard facing, the bars are placed on a table with the edge to be hard surfaced resting against a copper strip. The table will accommodate one of the 116-in. bars, or several of those of shorter length. The copper strip serves as a flux retainer and as a stopper along the cutting edge, permitting the hard facing material to be laid at the extreme edge of the steel. Scrap steel blocks are likewise placed at both ends of the bar, or at both ends of the series of shorter lengths. This eliminates time consuming hand repairs at the ends of the bars, or the finishing of the ends of the bars by hand if the bead were started several inches from the ends.

Since there is always a tendency for the steel to warp during the application of the hard facing, the bars are clamped against a steel plate on the welding table and pneumatic clamps, spaced 18 in. apart, apply firm pressure.

The welding head is positioned over the point at which the bead will start, with the rod on the scrap steel at the end of the bar. The welding head is

mounted on a track that parallels the cutting edge. With a current of about 600 to 700 amp., the head travels along its track at the rate of about 19 in. per min., and a layer of hard material about ⅛ in. thick is deposited in one pass. The deposit is remarkably even in thickness and width, and only rarely does a defect require manual arc repair.

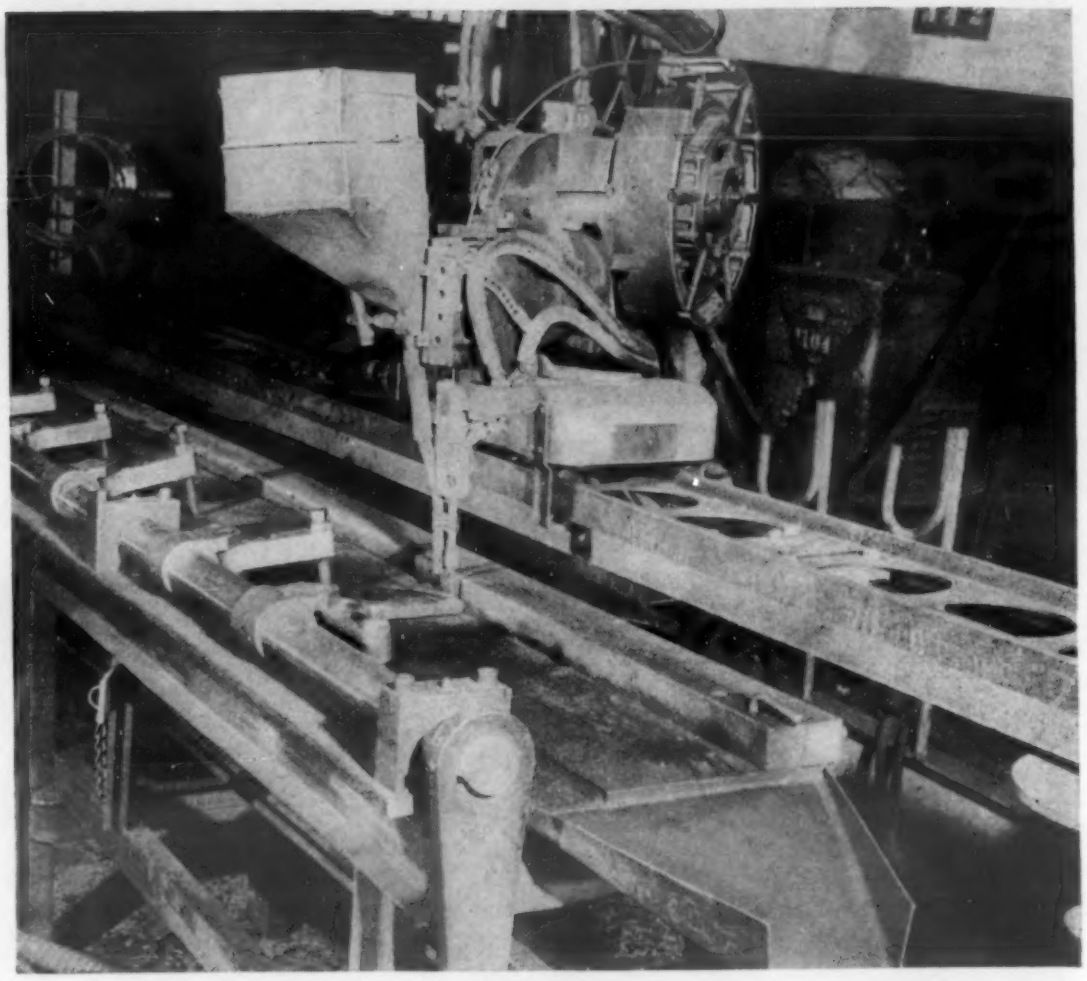
After the travel has been completed and the slag broken away, the bars are removed from the table and the ends are cleaned. If several short bars have been laid end to end on the table for continuous hard facing, the individual bars are broken apart. A stress relieving treatment in a furnace for 4 to 6 hr. at about 1250 F follows.

The final operation in the forming of the cutter bars is the beveling of the steel just behind the hard surfaced cutting edge, so that the bottom of the bar will be parallel to a theoretical soil surface when the bar is in its inclined working position. This is done in a Tractograph flame cutting machine with slight adaptations to get high production. The cutter bars are placed in two parallel rows, in a vertical position, and two cutting heads are used to make simultaneous cuts, one along each row. The heads are set at the angle desired in the beveled edge—about 25 deg.—and are so positioned that the bevel begins about ⅛ in. behind the layer of hard facing, so that there is a little steel behind the facing even at the extreme edge of the bar. In service the steel rapidly wears away, leaving a sharp edged bar with a hard surfaced edge. This method prevents any deterioration in the hard facing that might result from actual contact with the cutting flame.

The last operation consists of a heat treatment to develop best properties in the bar. The bars are heated in a furnace and quenched in oil to develop a hard spring temper in the steel, giving the hardness required along with good toughness. As they come from the heat treatment, ready for installation in earthmoving equipment, the bars possess the following hardnesses:

On hard surfaced edge:	R. 52 to 54
On body of steel bar:	R. 30 to 36

Cutter bars produced by this method have given excellent results in the field. Hardness is satisfactory, and the toughness of the part is adequate for the severe service. In the plant, the method makes for rapid production with standard equipment. The pieces are uniform and the production is efficient.

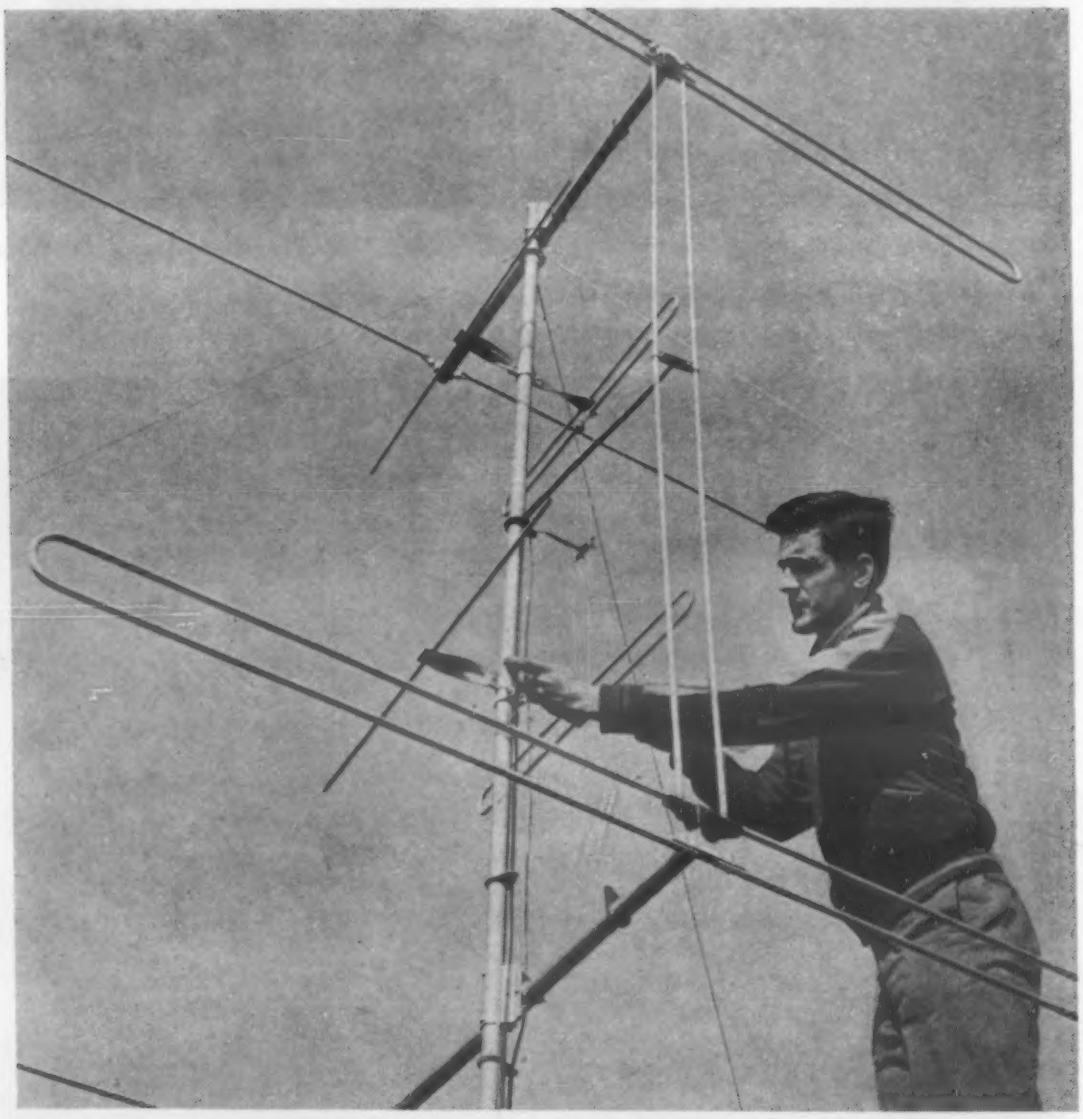


Shown here is the set-up used for automatic hard facing of cutter bars used in earthmoving equipment.

Hard facing metal is being deposited along the cutting edge of the steel cutter bars.

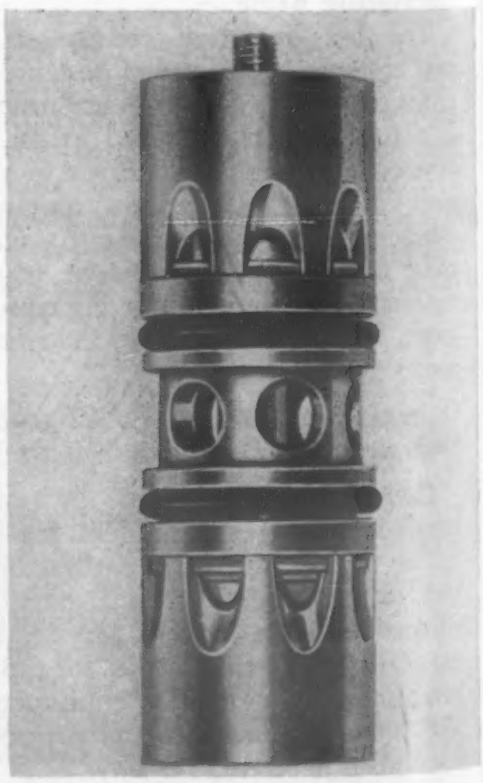
Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .



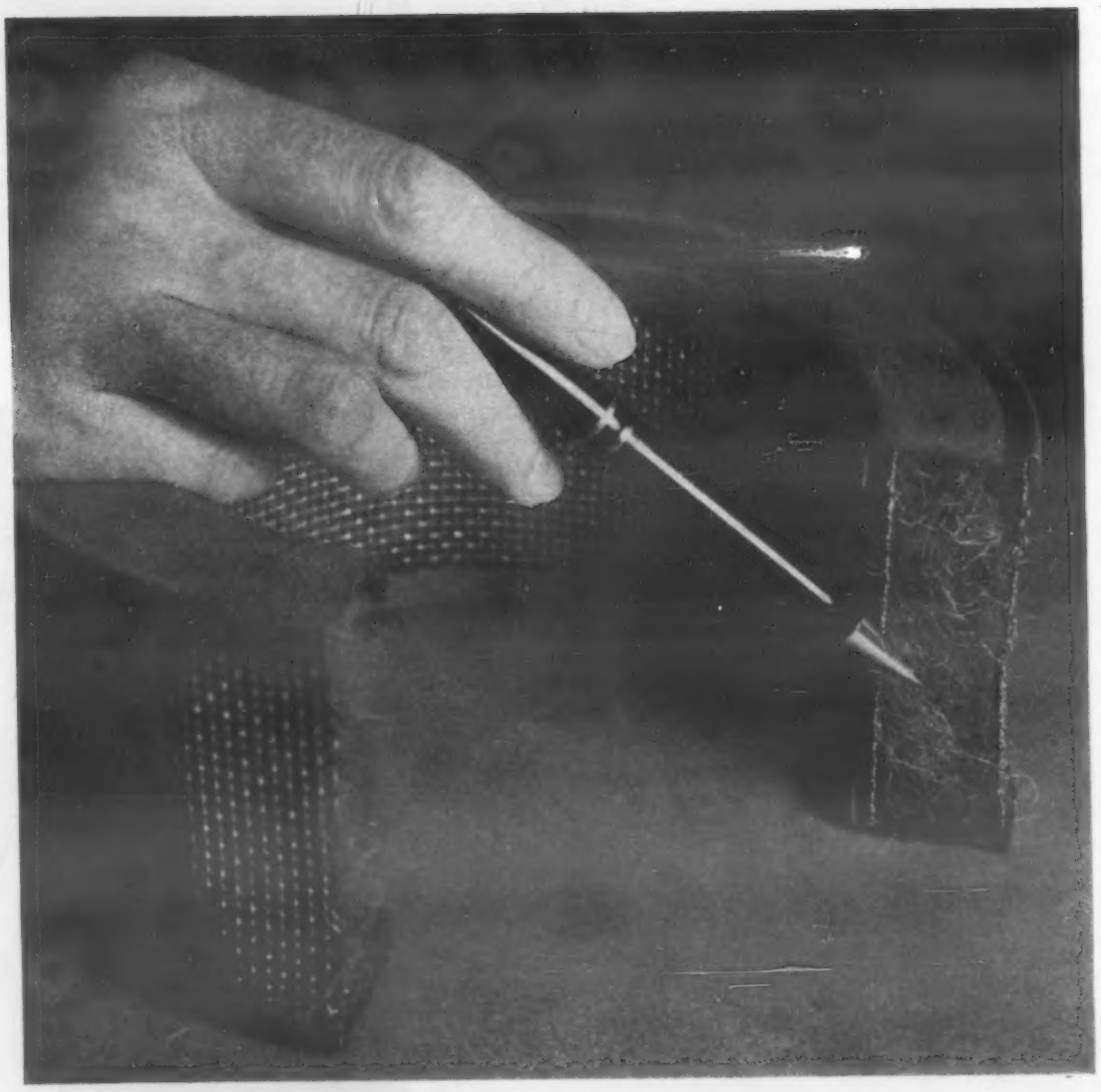
STEEL TUBE TV ANTENNA *Affording superior corrosion resistance and structural rigidity, the "Perma-tube" welded tubing produced by Jones & Laughlin Steel Corp. is currently used for television antennae manufactured by Ward Products Corp. This tubing is finished with a Vinsynite pre-treatment and a pigmented coating with a vinyl resin base. Under bending, expanding and other cold-forming, the "Perma-tube" finish flows with the metal and does not chip or flake off within the limits of distortion of the steel. The outstanding deflection value of the steel, contrasted with aluminum, reduces antenna vibration, which causes distortion of the image on the television screen. The new antenna material also has greater wind strength and can carry higher ice loads than antennae of less rigid metal. All sections and attachments of the antenna are joined mechanically by inserting, clamping or bolting. The installed assembly will stay tight, as the metal will not flow or work loose once the sections are joined.*

CORROSION RESISTANT AIR VALVE *The solenoid-operated air valve below is manufactured by Viking Products Co. of corrosion resistant metals, incorporates a Neoprene rubber gasket, and has the added advantages of long life, interchangeability, ease of installation, and fast, reliable action. The "Ring-Seal" valve, a 3-way or 4-way, 3-, 4- or 5-port assembly, has components of stainless steel and bronze and operates smoothly at speeds as high as 600 strokes per min. It is designed for air pressures to 105 psi. and for operation on 110-v. a.c. 60-cycle current. The valve assembly is removable from the housing at either end without disconnecting any piping.*



HIGH STRENGTH STEEL SKIDS

Designed to reduce deadweight during haulage and at the same time withstand shock loads during loading and unloading operations, these skids for automobile haulaway rigs are produced by Mechanical Handling Systems, Inc. of Jones & Laughlin Otiscoloy high strength steel. The skids have 18-gage high strength steel treads resistance welded to side channels of 12-gage steel. This construction results in a 12-ft. skid which weighs approximately only 100 lb.



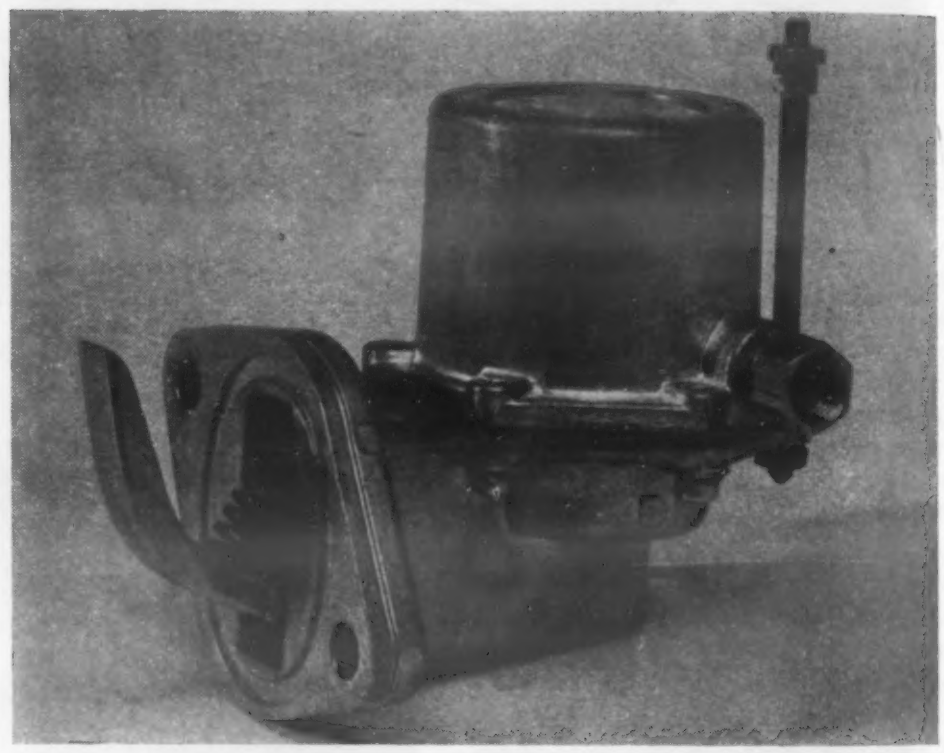
SYNTHETIC FIBER AND WOOL FILTER

Supplanting the fine copper turnings customarily used in filters of this sort, a new material composed of casein fibers and pure wool impregnated with tricresyl-phosphate is used in the carburetor air filters produced by the Fram Corp. These synthetic fibers, produced by Rubberset Corp., and known as Caslen, provide such controllable features as length, diameter and tightness of curl to assure interlocking of the finished material and to prevent matting. Bats of the fiber and wool composition are tightly packed in the metal filter cartridge screen and assembled to the standard carburetor resonating chamber in the conventional manner. The new type filtering material should not be washed in gasoline, kerosene or solvents, and should not be oiled as the conventional copper filters are.

Materials at Work

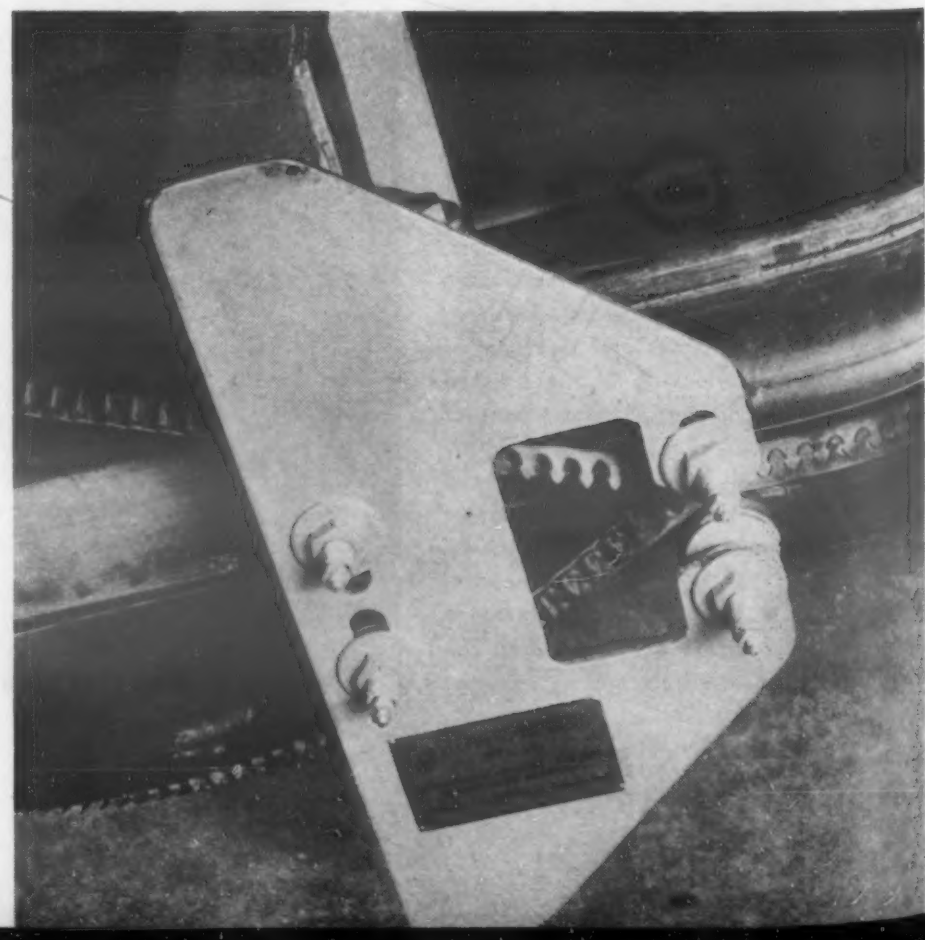
MAGNESIUM GANGPLANK

Replacing the crude, heavy, wooden structures conventionally used, this lightweight magnesium gangplank was developed by Magnesium Co. of America for sea-going tanker use. Retaining all the advantages of its wooden predecessor but reducing weight from 1200 to 500 lb. for a 36-ft. length, this magnesium innovation is currently produced in a variety of types and lengths for every maritime requirement.



DIAPHRAGM-TYPE FUEL PUMP

A newly-designed fuel pump utilizing a single, soft-type valve of synthetic rubber for both the inlet and outlet sides, instead of the two or more hard-type valves conventionally used, is currently in production by the F. L. Jacobs Co. for use in limited quantities in taxicabs made by Chrysler Corp. Pliability of the synthetic rubber valve provides easier maintenance of vacuum or pressure than if a hard-type valve is used. In addition, the pump has two large equalizing domes, one on the inlet and one on the outlet side, to maintain a more even and constant flow of fuel through the pump.



RUBBER "ZIPPER" BELTS

Rubber belting equipped with molded-in "zipper" teeth, and designed for conveyor-elevator handling of bulk foods, chemicals, unfired ceramic pellets, or any granular, flaky, or pulverized material without breakage or contamination are produced by B. F. Goodrich Co. for Stephens-Adamson, manufacturer of the "zipper" belt conveyor. The belt can travel horizontally or vertically, on slopes and curves, and is extremely adaptable where space is limited. The rubber teeth on the belt can be locked or unlocked at any point by use of rollers which operate on the same principle as the tab on a conventional slide fastener. The rubber teeth have the advantage of extreme flexibility, resistance to shock and wear, and noiseless operation. Power consumption compares favorably with conventional belt conveyors and is well under the average for most types of elevators by virtue of its simplified design and lightweight materials.

Transparent Plastics Compete with Glass in Many Applications

Because of their clarity, flexibility and formability, glasslike plastics are finding use in many fields where glass was formerly the only material available.

by KENNETH ROSE, Western Editor, Materials & Methods

• GLASS HAS for centuries held a place almost unique among materials because of its transparency. A glance at the list of crude glazing materials other than glass that have been used of necessity—oiled paper, dried fish membranes, oiled skins of animals, mica, etc.—shows the preeminence of glass in this field. Truly, glass has stood practically alone as a transparent material for glazing and for industrial use.

Glass, however, has some limitations, the most important one being its frangibility. Ceramics engineers and research workers have sought a means of producing flexible glass for centuries, without real success. The development in recent years of glass so heat treated as to possess high strength under certain conditions has been a real step forward, and the laminated glass in which shattering is practically eliminated by a plastic interlayer is another approach to the problem. Neither development, however, has solved the problem of the inherent weakness of glass to localized impact.

The development and production of plastics has brought to the materials engineer the first real competitors with glass in clarity. Fused quartz and certain minerals, such as calcite and fluorite, have found a limited use in optics for windows in furnaces, for laboratory ware, etc., but they have always been special purpose materials of sharply limited utility. With the development of plastics of good clarity, many fields where glass had been without competition are now giving the new materials consideration. In addition, new fields have been opened to the new transparent materials because of their flexibility, formability, or for other reasons.

Plastics having this quality of excellent transmission of light are found among both the thermosetting and the thermoplastic types. Because of considerably greater ease of forming, and better stability of the clarity of the material, the thermoplastics are favored among the clear types. All of the transparent thermosetting types show a tendency to yellowing that so far has not been completely overcome.

Glass and Plastics Compared

For the sake of comparison, some of the properties that make glass a valuable material in industry are:

(1) It can be produced in a very high clarity. The chemistry and techniques of glassmaking are now well understood, and the faint coloration that was once a residual from the metallic oxides can be almost completely removed. Compounds of manganese are the principal decolorizers for glass.

(2) It possesses good resistance to distortion at elevated temperatures. Glass softens gradually at temperatures above about 700 to 800 F for "soft" glass, higher temperatures for the boro-silicate or other heat resistant glass. Mild steel begins to soften, or lose strength, at about the same temperature range.

(3) It shows excellent resistance to chemical attack. Only hydrofluoric acid and strong caustic alkalies will attack it.

(4) It has a high hardness, equal to the hardness of spring steel. This is of great value in maintaining clarity, as the effect of tiny scratches is first to produce "haze."

(5) The index of refraction is controllable within limits. This is of importance to the optical industry.

(6) It can be fabricated by a wide range of hot-forming methods. Molding, blowing, welding, pressing, etc., are well adapted to processing of glass.

(7) It can be metallized by the mirror reaction, or by other methods.

A few of its disadvantages are:

(1) It is rather heavy. Specific gravity is about 2.8 for common types of glass.

(2) It is frangible. The readiness with which glass shatters at a blow is one of its worst disadvantages.

(3) It is quite notch-sensitive.

(4) It cannot be cold-formed, except by cutting or grinding.

(5) Riveting and bolting are not generally successful.

The glasslike plastics, in contrast, have the following properties:

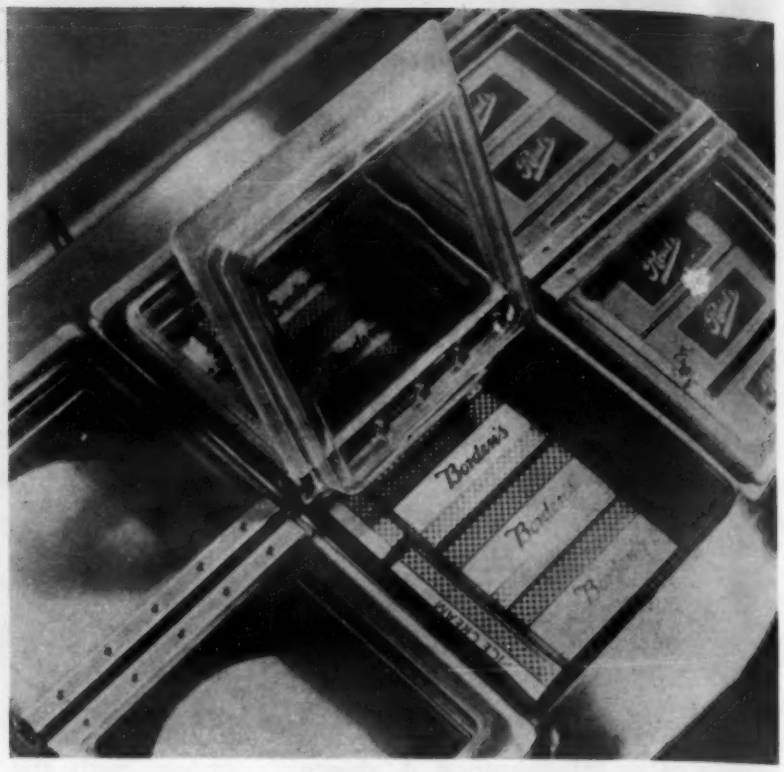
(1) Some types are capable of an optical clarity rivalling that of glass. Certain of the allyl polyesters, the methyl methacrylates, and the polystyrenes have been used for lenses and prisms in binoculars, and for similar purposes having rigid optical requirements.

(2) Chemical resistance is variable, but is generally much inferior to that of glass.

(3) The weight of all types is lower than that of glass. This feature, along with the ease of forming the plastics sheet into complex shapes, is its greatest advantage for aircraft glazing. As the glasslike plastics enter the container field as containers or closures, the saving in shipping costs combined with reduced breakage become important factors.

(4) Elevated temperature resistance is far below that of glass. The thermoplastic types usually start softening at about 130 to 140 F, and even the translucent thermosets are

Both excellent clarity and heat resistance are features of this pyrometer case of polystyrene. (Courtesy Koppers Co., Inc.)



Lids for ice cream cabinets are made of clear acrylic, 2 in. thick. (Courtesy Rohm & Haas Co.)

not recommended for service much above 210 F. Recently several important new polystyrenes with resistance to temperatures well above 200 F have been announced, and there are heat resistant grades of methyl methacrylates that are usable to about 200 F.

(5) All of the plastics under consideration are much softer than glass. This is one of the most important limiting factors when plastics are considered for glazing, as it means a rapid increase in the haze value during service, due to tiny scratches over the surface.

(6) All of the glasslike plastics are breakable, but are not shatterable to the same extent as glass. This is another feature that has given certain of the clear plastics an advantage for glazing of aircraft, especially military aircraft.

(7) The plastics are more easily formed than glass. They can be hot formed, at very moderate temperatures, machined, ground, polished, welded, adhesion-bonded, riveted or bolted, etc. A valuable feature of the thermoplastic types is their adaptability to pneumatic forming, with or without molds.

Kinds of Glasslike Plastics

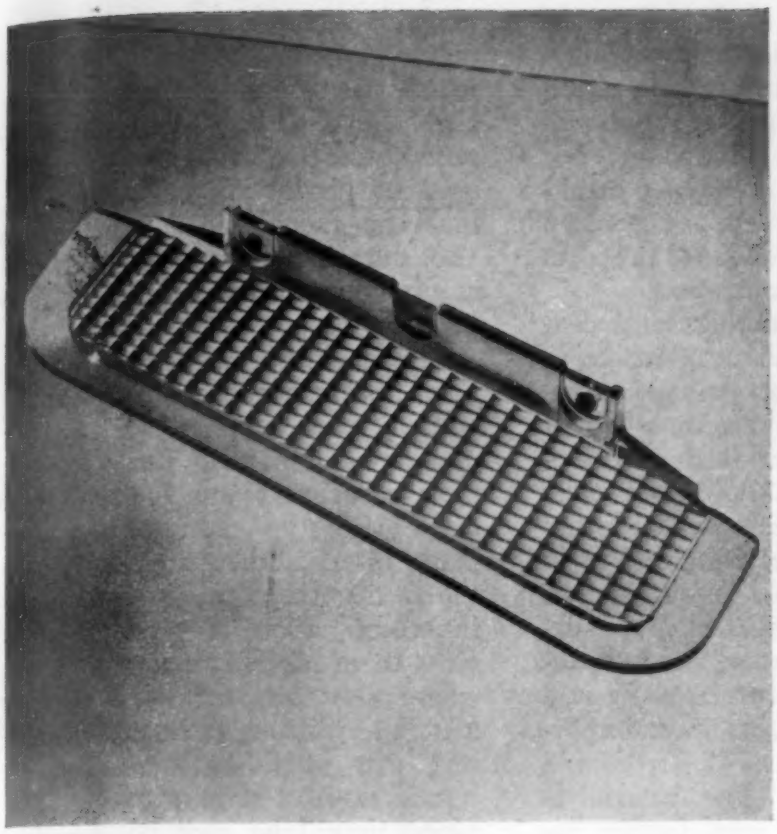
The most important glasslike plastics are those of high clarity that are suitable for certain types of glazing and for optical use. These include some allyl polyesters, the methyl methacrylates, and some polystyrenes.

Allyl Polyester—Allyl polyester resins are especially adapted to low-pressure laminating, but when used as a glasslike material, they are usually cast in sheet, rod or tube form, or in more intricate form. Since they are thermosetting, when polymerization is completed in the mold the material is left in an infusible form. In the case of the allyls, however, the material can be heated and postformed to some extent. Molds should be of iron or steel, aluminum, the fusible alloys, glass, and glazed ceramics; copper, brass and rubber must be avoided, as they tend to inhibit polymerization. Polymerization takes place at moderate temperature and without use of pressure, in the presence of a catalyst, so that no complicated, expensive equipment is needed.

The plastic shows excellent chemical resistance, heat resistance to about 210 F, good surface hardness, and high clarity. There is sometimes a tendency to develop a slightly yellow tinge. Allyl polyesters find use in transparent enclosures for aircraft, covers for dials and indicators, cast lenses and prisms, television lenses, de-icer windows, etc. Incorporation of a pigment for absorption of some of the sun's rays makes the material for sun visors. Phosphorescent or fluorescent materials can be used to obtain novelty effects in signs.

Methyl Methacrylate — The methyl methacrylates were the first of the plastics of brilliant clarity to be offered to industry. They are materials of unlimited color possibilities, and have good optical properties generally. They still possess the best resistance to deterioration by sunlight and weather. Being a thermoplastic, the general purpose material is suitable for use in temperatures up to about 140 F, while a heat resistant grade is usable at temperatures about 50 F higher. The resin can be cast or molded. In the case of molded parts, the quality of the surface of the piece, and therefore its clarity, is largely dependent upon the surface of the mold and upon careful molding procedure. The heat resistant grade is somewhat more difficult to mold than the general purpose material.

In addition to the molded material, cast sheets can be formed at moderate temperatures. In order to preserve the optical qualities of the material when formed into such pieces as aircraft enclosures, the sheet is frequently blown to form by air pressure, without the use of a mold of any sort. Blowing a slight convexity into a small sheet of the acrylic can produce a piece from which a curved door for aircraft can be cut, while blowing a large bubble



An intricate prism molding is obtained at low cost using polystyrene for this refrigerator light deflector. (Courtesy Koppers Co., Inc.)

Glasslike molded acrylic medallion for automobile radiator grille. (Courtesy Rohm & Haas Co.)

from a heated sheet may give the basic form to a gun blister or a cabin enclosure. In either case the air is admitted slowly under the sheet as it is held in a fixture, and the heated plastic gradually expands to the desired form. Only about 2 psi. of air pressure is needed. Careful control of the temperature of the plastic and of the rate of forming will prevent striations developing in the material.

Another property of the acrylics that is much used in display is its ability to "pipe" light. Internal reflections in a tube of the material cause a beam of light to follow turns in the tube, thus transmitting the light along a fixed path, straight or curved. Surgical instruments make use of this property of the acrylics also. In addition to store display easels, in which brilliant edge-lighted effects can be obtained, the principle is finding some use in outdoor signs. Fluorescent and phosphorescent pigments can be incorporated into the plastic when desired. It can also be metallized for mirror effects, or for the metallic appearance itself.

Methyl methacrylates are used in lenses for protective goggles, transparent figures for sales display, transparent models of mechanical parts for study or demonstration, television lenses, for decorative parts of coin machines, drafting equipment, reflectors, name plates, automobile and aircraft panels, dial covers, household appliances, etc.

Polystyrene—The polystyrenes are in the favorable position of possessing a combination of desirable properties, and of being low in price. They are brilliantly clear, optically satisfactory, and are highly resistant to acids, alkalies, alcohol, and many organic solvents. In addition, they are practically impervious to water, have good dimensional stability, are one of the lightest of the plastics groups, are free from taste or odor, have good low-temperature properties, and can be produced in heat resistant types suitable for use to about 210 F or higher. They also have a wide range of fabricating possibilities, with excellent moldability, even in the heat resistant grades. Like the acrylics, the polystyrenes possess the property of piping light.

Not all grades of polystyrene are clear water-white, so it is necessary to specify the high-clarity material when it is wanted. Polystyrene is one of the most versatile and widely used general purpose thermoplastics, and the end use for which the material is intended should always be specified so that the most suitable grade will be obtained. Polystyrene plastics have been used successfully for lenses and prisms in lightweight binoculars, for bottles and bottle closures, for glasslike kitchen and household gadgets, wall tile, light fixtures, etc.

Cellulose Nitrate—Cellulose nitrate was the first of the modern glasslike plastics made available to industry. It is transparent but tends to darken, especially upon exposure to sunlight. It found an early use in transparent panels in the cloth and leather tops for carriages and automobiles. This material tended to yellow badly due to the slow liberation of acids and oxides of nitrogen. Addition of acid acceptors to the formulation greatly decreased the yellowing. Cellulose nitrate is a thermoplastic and is one of the toughest of the plastics, and this toughness combined with transparency is utilized in lenses for flashlights, visible ink chambers for fountain pens, etc. Its transparency is an advantage for such drawing instruments as triangles and curves.

Cellulose Acetate—Cellulose acetate, another early arrival, is available in various types capable of good transparency. With cellulose acetate the tendency to darken had its origin in secondary contamination of the materials, and improvement in (a) the purity of the chemicals themselves, (b) the materials in the plant equipment, and (c) plant techniques, with special emphasis upon cleanliness, brought about substantial lessening of discoloration.

Cellulose acetate can be varied in its properties by control of the viscosity of the acetate itself, and by varying the type and amount of plasticizer used. Suitable formula-

tions are used for sunglass lenses, lamp shades, etc. While the acetate possesses better resistance to sunlight than the nitrate, it has rather poor resistance to cold flow. An aircraft grade has been developed for aircraft glazing. Properties of the acetate butyrate are much like those of the acetate, while the propionate shows superior physical properties, especially in impact resistance and dimensional stability, but is not produced in transparent form.

Ethyl Cellulose—Ethyl cellulose, a thermoplastic, is available in transparent grades. It has excellent impact resistance and low-temperature properties, and dimensional stabilty is maintained even in excessively moist air. It goes into transparent flashlight cases and lenses, fountain pen barrels, transparent radio panels, etc. Another glasslike thermoplastic resin is cellulose propionate. It is a translucent rather than a transparent material with excellent strength properties.

Melamine- and Urea-Formaldehyde—The melamine and urea thermosets are not available as clear materials but they are translucent. They are included in this group of materials only because they are widely used as a substitute for opal glass and for lamp shades and other translucent pieces in competition with glass. These plastics have excellent color stability, and show no significant tendency to yellowing. They have light weight and lessened breakage to recommend them as compared to glass. These materials are favorites for translucent buttons also.

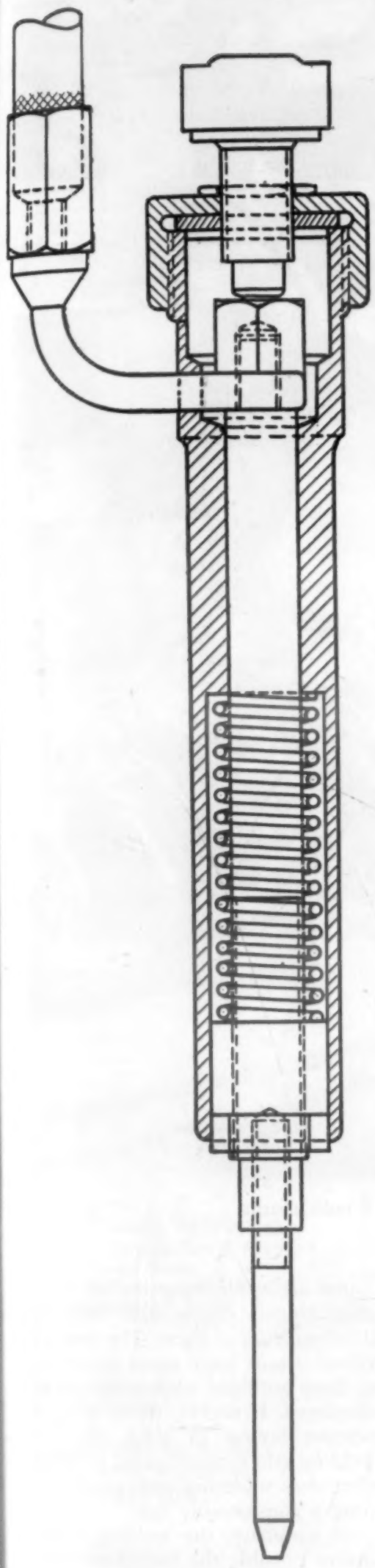
Polyethylene—Another translucent material not particularly glasslike in its properties, but becoming increasingly important as a competitor of glass in several uses, is the thermoplastic polyethylene. It has unusually good chemical resistance. Strong acids and alkalies, alcohol, and most organic solvents have no effect upon polyethylene. It has excellent resistance to moisture vapor, and is tasteless and ordorless. Insofar as it is a competitor of glass, its most important uses are in tumblers, bottles and shipping containers. The material is slightly flexible as used, further reducing the danger of breakage, and making possible such specialties as the squeezable bottle.

In addition to the above transparent and translucent materials, many of the vinyl polymers and copolymers are translucent. They are not given separate listing here because their applications are seldom in fields where they are chosen for their glasslike properties, or in which they are in competition with glass. Polyvinyl butyral, the most important of the laminating materials used in production of safety glass, must be mentioned in this group also, though it is chosen for this use as a bonding agent rather than for its glasslike properties.

The glasslike plastics, then, have given the materials engineer his first really clear material for product fabrication that will compete with glass in some respects. No one of the glasslike plastics could completely replace glass. Rather, they are high-clarity materials offering an interesting combination of properties that gives them preference in some fields where glass was formerly the only material available, as in aircraft glazing; that opens new fields, as in certain types of novelty display using piped light; and that constitutes a minor material in some fields where glass has long been established and still has preponderant advantages, as in bottles. In still other fields, glasslike plastics remain materials not in practical use, but available as possible future contenders if the cost picture should change or some unsatisfactory property be improved.

General Properties of the Glasslike Plastics

Resin Type	Trade Names	Haze Value, %	Refractive Index	Luminous Transmittance, %	Specific Gravity
Allyl Esters	Selectron, Kriston (production halted, at least temporarily)	1 to 2	1.50-1.57	90-92	1.30-1.40
Methyl Methacrylates	Lucite, Plexiglas	1 to 3	1.485-1.50	91-92	1.18-1.19
Polystyrenes	Bakelite, Loalin, Loalex, Styron, Lustron, Lustrex, Cerex, Plexene, Koppers, Chemaco	5 to 10	1.59-1.60	93	1.05-1.065
Cellulose Nitrates	Pyralin, Nitron, Nixon C/N	2 to 4	1.49-1.51	89-92	1.35-1.40
Cellulose Acetates	Hercules, Koppers, Chemaco, Lumarith, Tenite I, Plastacele, Fibestos, Nixon C/A	3 to 8	1.46-1.50	80-90	1.27-1.33
Cellulose Acetate Butyrates	Tenite II	3 to 10	1.46-1.49	80-95	1.19-1.23
Ethyl Celluloses	Ethocel, Hercules, Chemaco, Koppers, Celcon, Nixon E/C	—	1.47	—	1.10-1.14
Cellulose Propionate	Forticel	—	1.47-1.48	—	1.16-1.21
Polyethylenes	Bakelite, Polythene	—	1.51	—	0.92
Urea-Formaldehydes	Beetle, Plaskon	—	—	—	1.47-1.52
Melamine-Formaldehydes	Melmac, Plaskon, Resimene	—	—	—	1.47-1.52



Sectioned view of welding gun.

Joining Parts to Passivated Zinc Surface Accomplished Through Resistance Welding

This new, rapid spot welding method solved a difficult joining problem and permitted the use of more economical finishing methods.

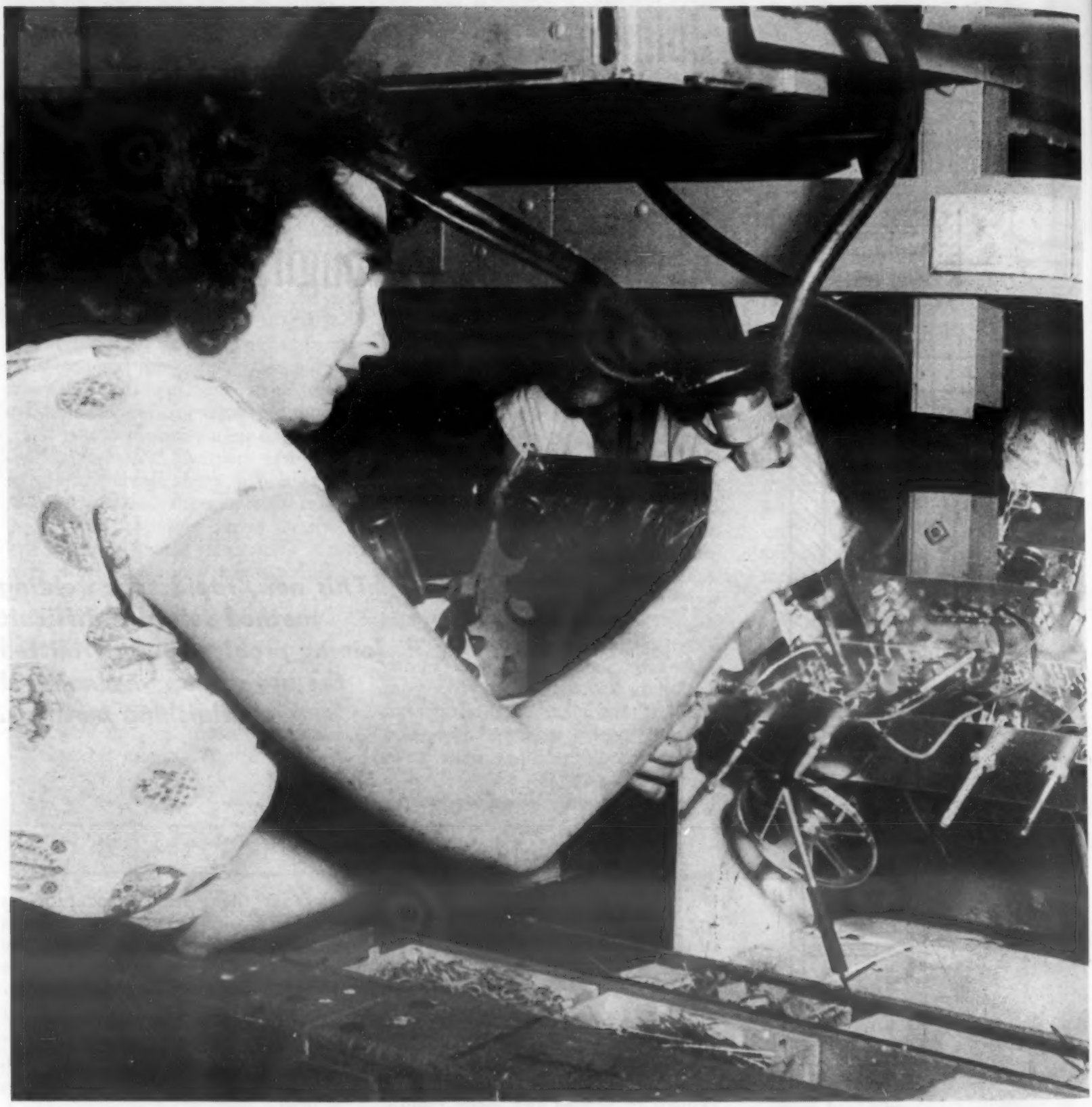
● AN INGENIOUS resistance welding method developed by engineers of the Electronics Park plant of General Electric Co., Syracuse, N. Y., seems to offer interesting possibilities to others faced with difficult joining problems. The method is possible through the development of a spring actuated hand gun which is convenient to handle and easily manipulated.

The welding method was developed to overcome problems encountered in soldering small parts to passivated zinc-piated steel radio chassis. A combination of circumstances made it more desirable to change joining methods than to use a different method of finishing the steel chassis.

In quality radio sets it is desirable that the steel chassis remain free of corrosion and discoloration for the life of the set. For some time the desired finish was obtained by plating the steel sheet of the chassis with cadmium. However, the high price of cadmium as opposed to many other plating materials led to the use of zinc for the plating. Zinc provides good corrosion resistance, but has a tendency to discolor, particularly where it has been touched by human hands. As a solution to the discoloration problem, a passivating treatment was decided upon for the zinc surfaces. For this purpose Luster-on, manufactured by the Chemical Corp., is used.

The solution of the finishing problem led to a new set of problems. It is more difficult to solder to the passivated zinc surface. Soldering can be accomplished by the use of a special flux, and the corrosive residue can be evaporated if the iron is operated a little hotter than usual. This method is satisfactory for many manual operations. However, the intricate assembly line at General Electric made it necessary to preplace the spots of solder on the radio chassis and then, before assembling, the entire unit was cleaned to make certain that no flux remained. This was both costly and time consuming, so a cheaper, faster method was sought.

The resistance welding method



The gun is shown here in the actual operation of spot welding on a radio chassis.

finally developed utilizes a standard Thryratron control panel and operates on either 220- or 440-v., single-phase current. The ground lead of the welder is attached to the chassis upon which welding is being done. Welding current is applied by pressing the tip of the welding gun against the materials between which a joint is desired. In some cases a foot pedal is provided for those circumstances where two welding heats are required. The use of the gun alone will provide the low heat current, and by simply stepping on the foot pedal a higher heat is provided. The low heat is used when attaching tinned wire to the chassis and the higher heat is used for the attaching of copper strip.

The welding gun, a sketch of which accompanies this article, is composed of a handle within which is placed a welding electrode having a 1/8-in. tungsten tip. When the gun's tip is pressed against the spot where a joint is desired, the pressure causes a spring to actuate a microswitch, which closes the welding circuit. Release of the pressure again opens the circuit.

On the production lines where such devices are now being used, joints are made between 18- to 22-gage tinned copper-base wire and 0.005-in. copper sheet. The joints attained are at least equal in strength to those provided when soldering was employed. However, there is an important saving in time, since the welding gun is much easier to manipulate than soldering tools and heating time is considerably less.

In summary, the welding method makes possible the use of more economical and highly satisfactory finishing methods, plus being much faster from a production standpoint than the soldering formerly used.

Materials Engineering File Facts

NUMBER 182
November, 1949

MATERIALS DATA SHEET

Wrought Magnesium Alloys

Typical Properties

Property \ ASTM / Am. Mag. Corp. / Dow Chemical Co.	MI AM3S M	AZ31X AMC52S FS-1	AZ61X AMC57S J-1	AZ80X AMC58S – F O-1 HTA	TA54 AM65S D
COMPOSITION, %	Mn, 1.20 min. — —	Al, 2.5-3.5 Zn, 0.6-1.4 Mn, 0.20 min.	Al, 5.8-7.2 Zn, 0.4-1.5 Mn, 0.15 min.	Al, 7.8-9.2 Zn, 0.2-0.8 Mn, 0.12 min.	Al, 3.0-4.0 Sn, 4.0-6.0 Mn, 0.20 min.
PHYSICAL PROPERTIES					
Density, Lb./Cu. In.	0.064	0.064	0.065	0.066	0.067
Melting Temp. Range, F	1200	1050-1170	950-1140	900-1115	—
Thermal Cond., Btu./Hr./Sq. Ft./Ft./F, (212-572 F)	72.6	55.6	46.0	43.5	—
Coeff. of Exp. per F: 65 to 212 F	1.4×10^{-5}	1.4×10^{-5}	1.4×10^{-5}	1.4×10^{-5}	1.4×10^{-5}
65 to 750 F	1.6×10^{-5}	1.6×10^{-5}	1.6×10^{-5}	1.6×10^{-5}	1.6×10^{-5}
Spec., Ht., Btu./Lb./F (78 F)	0.25	0.25	0.25	0.25	0.25
Elect. Res., Microhms/Cm./Cm.[2], (Wrought, 68 F)	5.0	10.0	12.5	14.5	13.8
MECHANICAL PROPERTIES					
Modulus of Elasticity, Psi:	6.5×10^6	6.5×10^6	6.5×10^6	(see Note 1) 6.5×10^6	6.5×10^6
Tensile Str., 1000 Psi:					
Extruded[2]	26-38	35-39	40-45	40-49	—
Forged	36.0	—	43.0	46.0	40.0
Yield Str., 1000 Psi:					
Extruded[2]	23-28	23-28	22-32	23-35	—
Forged	23.0	—	26.0	31.0	28.0
Elongation, % (in 2 In.):					
Extruded	8-11	12-18	15-16	10-12	—
Forged	7	—	12	8	12
Compressive Yield Str., 1000 Psi:					
Extruded[2]	10-13	15-17	15-21	21-26	—
Forged	—	—	18.0	25.0	21.0
Hardness, Bhn.:					
Extruded[2]	42-46	49-50	55-60	60-67	—
Forged	47	—	55	69	52
Shear Str., 1000 Psi:					
Extruded	16.0	19.0	21.0	21.0	—
Forged	16.0	—	21.0	22.0	16.0
Fatigue Str., (End. Limit), 1000 Psi:					
Extruded	9.0	14.0	17.0	19.0	—
Forged	—	—	16.0	18.0	11.0
Impact Str., (Charpy), Ft.-Lb.:					
Extruded	2.1	3.2	3.0	2.2	—
Forged	—	—	2.2	1.8	2.0
THERMAL TREATMENT					
Annealing Temp., F	700	650	650	725	650
Extrusion Stress Relief Temp., F	500	500	500	400	—
Solution Temp., F	—	—	—	750	—
Aging Temp., F	—	—	—	350	—
Extrusion Ht. Treating & Aging Temp., F	—	—	—	600	—
FABRICATING PROPERTIES					
Hot-Working Temp. Range, F	550-650	450-650	450-650	275-375	450-820
Shortness Temp., F	—	820	780	775	850
Max. Red. between Anneals, %	20-25	20-25	—	—	—
Weldability:[4] Torch	A	B	C	D	B
Inert Gas Arc	A	A	A	C	C
Elect. Res.	A	A	A	A	B
Machinability Index (Free-Cutting Brass = 100)	500	500	500	500	500
Formability:[4] Hot	A	A	B	C	B
Cold	B	A	C	D	C
CORROSION RESISTANCE Resist. to Atmosphere	High	High	High	High	Good
AVAILABLE FORMS	Sheet, plate, rod, bar, extruded shapes, tubing, extruded hollow shapes.		Rod, bar, extruded shapes, tubing.		Rod, bar.
APPLICATIONS	Sheet, extrusions	Sheet, extrusions	Extrusions, forgings	Extrusions, forgings	Forgings
	Aircraft frame parts, textile, other high-speed reciprocating machinery, truck bodies, jet engine parts, etc.				

NOTES: [1] *Tensile, tensile yield and compressive yield strengths, and hardness of AZ80X can be increased several per cent by heat treating at some expense to the elongation.*
[2] *Generally, strengths and hardness of extruded bar are highest, extruded tubing lowest, and extruded shapes intermediate in the ranges of values given.*
[3] *Higher working temperatures can be used when heating hard rolled or aged alloys above the annealing or aging temperature is not involved.*
[4] *Letter A indicates most favorable property, D least favorable, etc.*

Prepared with the assistance of Dow Chemical Co. and American Magnesium Corp.

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TUBING

DIMENSIONAL ACCURACY

. . . that cuts machining and fabricating time, reduces scrap-loss; speeds production of hollow paris

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TYPES	Seamless (hot finished and cold drawn). Welded (from hot or cold rolled strip).
GRADES	Carbon, Alloy, and Stainless.
SIZES	Up to 8⅝" O.D. in full range of wall thicknesses.
QUALITY	Open-hearth, and electric furnace steels, including aircraft and magnaflux qualities.
CONDITION	Unannealed, annealed, tempered, normalized, or otherwise heat-treated as required.
SURFACE FINISHES	As rolled, as drawn, as welded, bead removed, turned, scale-free, and polished.

B&W SEAMLESS and WELDED TUBES

THE BABCOCK & WILCOX TUBE COMPANY
GENERAL OFFICES: BEAVER FALLS, PA. PLANTS: BEAVER FALLS, PA. AND ALLIANCE, OHIO

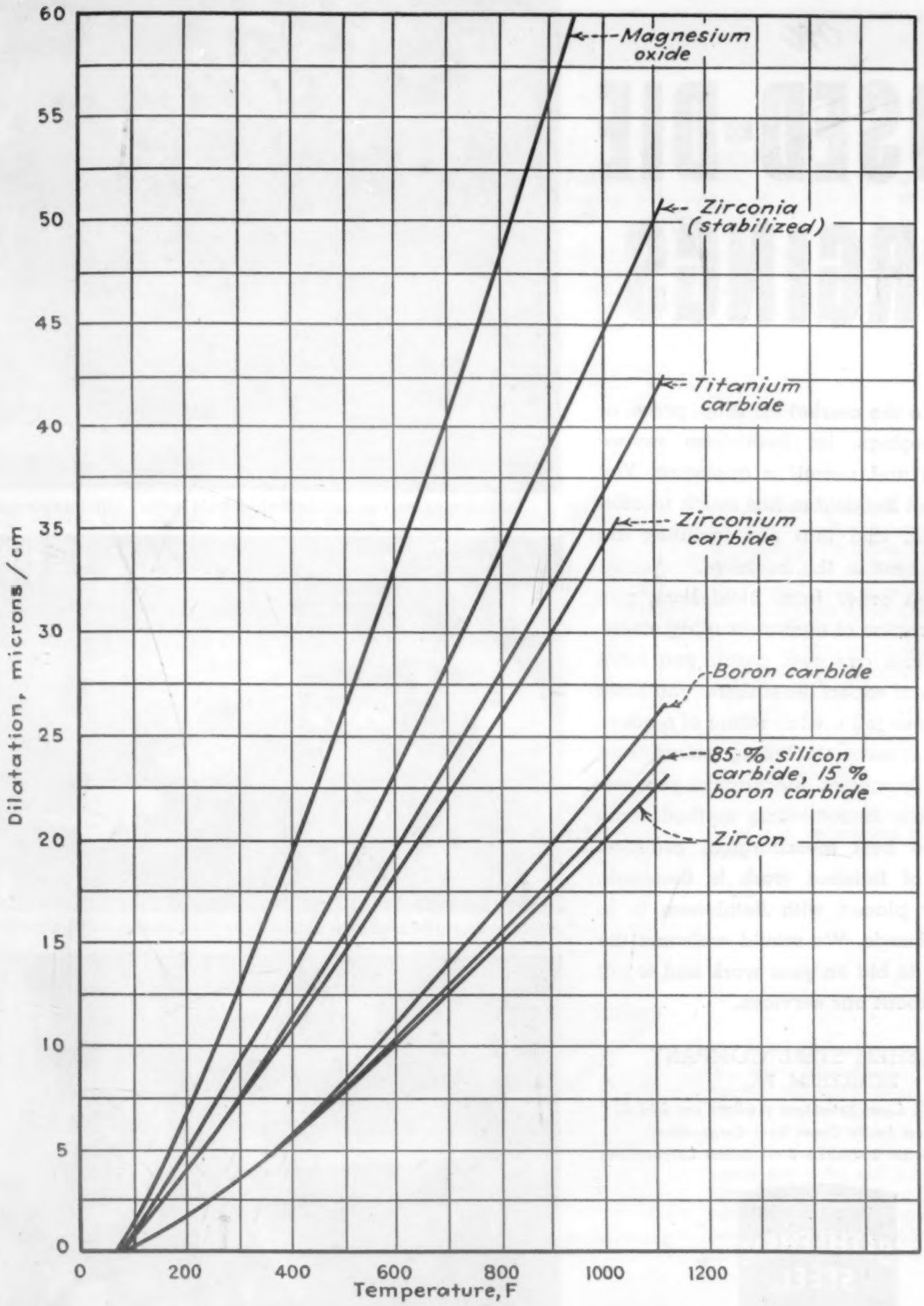
TA 1306-A

Materials Engineering File Facts

NUMBER 183
November, 1949

MATERIALS: Ceramics

Thermal Expansion Properties of Typical Hot-Pressed Ceramics



Data taken from "Physical Properties at Elevated Temperature of Seven Hot-Pressed Ceramics", by Gangler, Robards & McNutt, National Advisory Committee for Aeronautics.

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If you are in the market for drop, press, or upsetter forgings, let Bethlehem review your needs and submit a quotation. You will find that Bethlehem has much to offer in this field, and that our facilities are among the best in the business.

When you order from Bethlehem, you have your choice of carbon or alloy steels, available from our own plant; you have the services of expert die-sinkers; you have ready for your job a wide range of modern forging equipment, including steam and board drop hammers, mechanical presses, and upsetters. Heat-treating methods conform to the best metallurgical practice. Inspection of finished work is thorough.

An order placed with Bethlehem is in competent hands. We would welcome the opportunity to bid on your work and to tell you more about our services.

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BETHLEHEM, PA.

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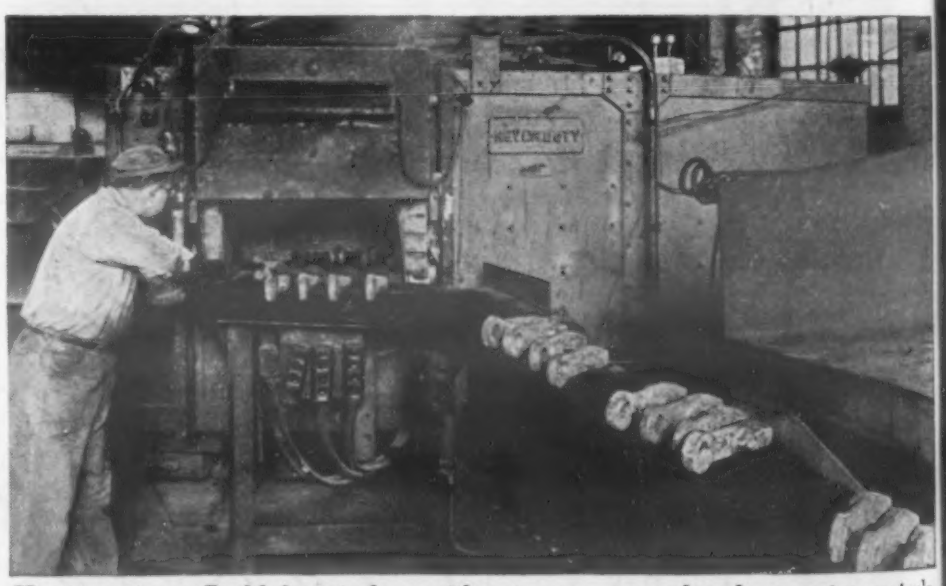
★ BETHLEHEM STEEL ★

2000-ton press, one unit in Bethlehem's battery of forging equipment.



Heat-treating at Bethlehem is done with extreme care and under precise controls.

Shot-blasting an order of drop forgings prior to inspection.

New Materials and Equipment

MATERIALS

Iron & Steel 82, 92, 100, 110, 120
Nonferrous Metals 80, 92
Plastics 88, 102, 104, 110
Other Nonmetallics 80, 104, 114, 124
Parts & Forms 80, 82, 100
Coatings & Finishes 88, 96, 124

EQUIPMENT

Heat Treating & Heating 79, 98, 100, 104
Cleaning & Finishing 80
Welding & Joining
82, 84, 86, 88, 106, 112, 120, 122
Forging & Forming 79, 90, 92
Machining 114, 120
Melting, Casting & Molding 94, 98, 100, 112, 122
Inspection & Control 82, 88, 90, 124

High-Speed Tool Steels Bright Hardened in Unconventional Unit

A uniquely constructed furnace for bright hardening high-speed tool steels has been developed by *Lindberg Engineering Co.*, 2444 W. Hubbard St., Chicago 12.

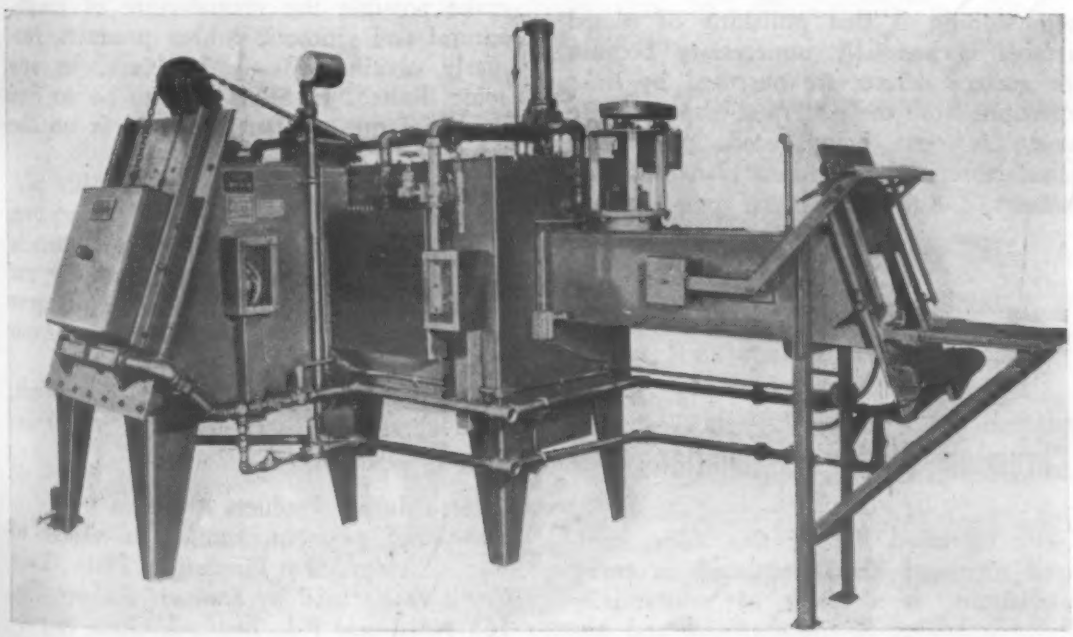
The new unit is claimed to harden molybdenum, 18:4:1, 18:4:2, or cobalt type steels totally free from carburization or decarburization. It is designed primarily for cutters, thread chasers, etc., that have fine cutting edges and cannot be ground or cleaned after hardening.

The furnace contains preheat, high heat and quench sections; the preheat is built at right angles to the high heat section. Quenching is by means of forced convection in a cooled protective atmosphere; sections of high-speed steel up to 2 in. can be fully hardened by the atmosphere quench.

Among the disadvantages of conventional installations corrected by this combination unit are: scaling of work when it is removed from the preheat into air and transferred to high heat; contamination of high heat atmosphere when charging door is opened; scaling and slight decarburization of the steel when it is removed from the furnace through air to the quench.

The protective atmosphere used is supplied by a separate atmosphere generator. An endothermic atmosphere generated from city, natural, propane or butane gases, or a charcoal-generated atmosphere can be used.

In order to extend this protection to the tempering operation, the company has provided retorts (supplied with the same protective atmosphere used in hardening) to be used in its standard air tempering furnaces.



This Lindberg furnace combines preheat, high heat and quench sections for bright hardening high-speed tool steels.

● *Taber Instrument Corp.*, 109 Goundry St., North Tonawanda, N. Y., has announced production of an improved model, No. 123, of its Thermocreaser, designed to make right angle folds on sheet plastic materials used in making rectangular transparent containers and other types of packages. Folds of less than 90° can also be made by a simple adjustment of the temperature of the folding blade, or by altering the shape of the groove in the folding die.

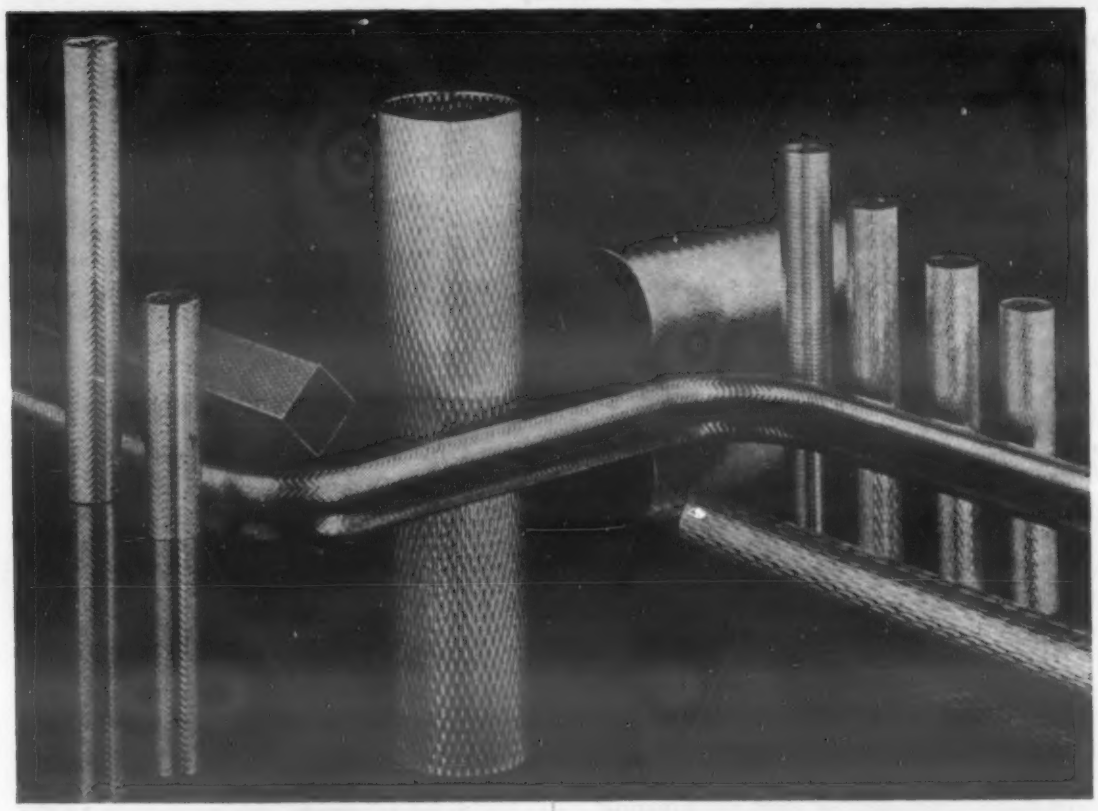
New Materials and Equipment
(CONTINUED)

Rigidized Welded Steel Tubing Has Strength, Attractiveness

Rigidized welded tubing of carbon, stainless, and low-alloy high-tensile steels is being produced by *Standard Tube Co.*, Detroit, under an exclusive agreement with *Rigidized Metals Corp.*, Buffalo, N. Y.

Rigidizing is a patented process for roll-formed and electric-resistance-welded into tubing. Because patterns are rolled on both sides of the strip with a male and female roll, 16 gage is the heaviest strip currently rolled.

An additional advantage of Rigidized metal tubing is that polishing of plated surfaces is generally unnecessary because fine surface defects are obscured by light reflections from the patterned material. The tubing is now being used by several manufacturers of chromium plated tubular products.



Rigidized welded tubing is now being manufactured by Standard Tube Co.

ing textured patterns in flat metal which redistributes the metal through the cross section, thus increasing stiffness, strength and impact value and, at the same time, producing attractive surfaces. In the production of Rigidized tubing, the patterns are rolled into the strip, subsequently

New Lead Alloy Has Longer Life in Chromium Plating Installations

A new lead alloy, named Nalco Metal, has been developed by *National Lead Co.*, 111 Broadway, New York 6, for longer service in chromium plating installations. Composition of the new alloy has not been disclosed.

The increased life of this alloy, compared to those it has replaced in many installations, is a result of substantially greater resistance to the corrosive and pitting action of chromic acid solutions. Corrosion tests conducted by National Lead Co. under certain typical conditions have shown an 11-day corrosion loss of only 1% for Nalco Metal compared to 50% for the 6% antimonial lead formerly used in chromium plating.

The alloy is used for tank linings, anodes and heating-and-cooling coils. Use of Nalco Metal is said to eliminate the need for anodic treatments to re-establish lead chromate protective coatings on linings and coils.

In sheet form, the new alloy is claimed to be as easily cut, trimmed and shaped to tank contours as the alloys previously used. In pipe form, the metal can be readily coiled or looped and bound, clipped or blocked into units of any desired design or form.

Nickel- or Chromium-Finished Round Edge Flat Wire Available

Round edge flat wire, furnished in nickel or chromium finish on steel base, is now available from *American Nickeloid Co.*, Peru, Ill. The smooth, rigid wire can be supplied finished on one or both sides.

Available sizes range from 0.035 to 0.125 in. in thickness and 3/16 to 2 in. in width. Standard length in nickel finish is 71 in. or 142 in. cut into two parts, neither part exceeding 95 in. In chromium finish, lengths are 70 in. or 140 in. cut into two parts, neither part exceeding 94 in.

Rubber Colored, Toughened by Extremely Fine Silica Pigment

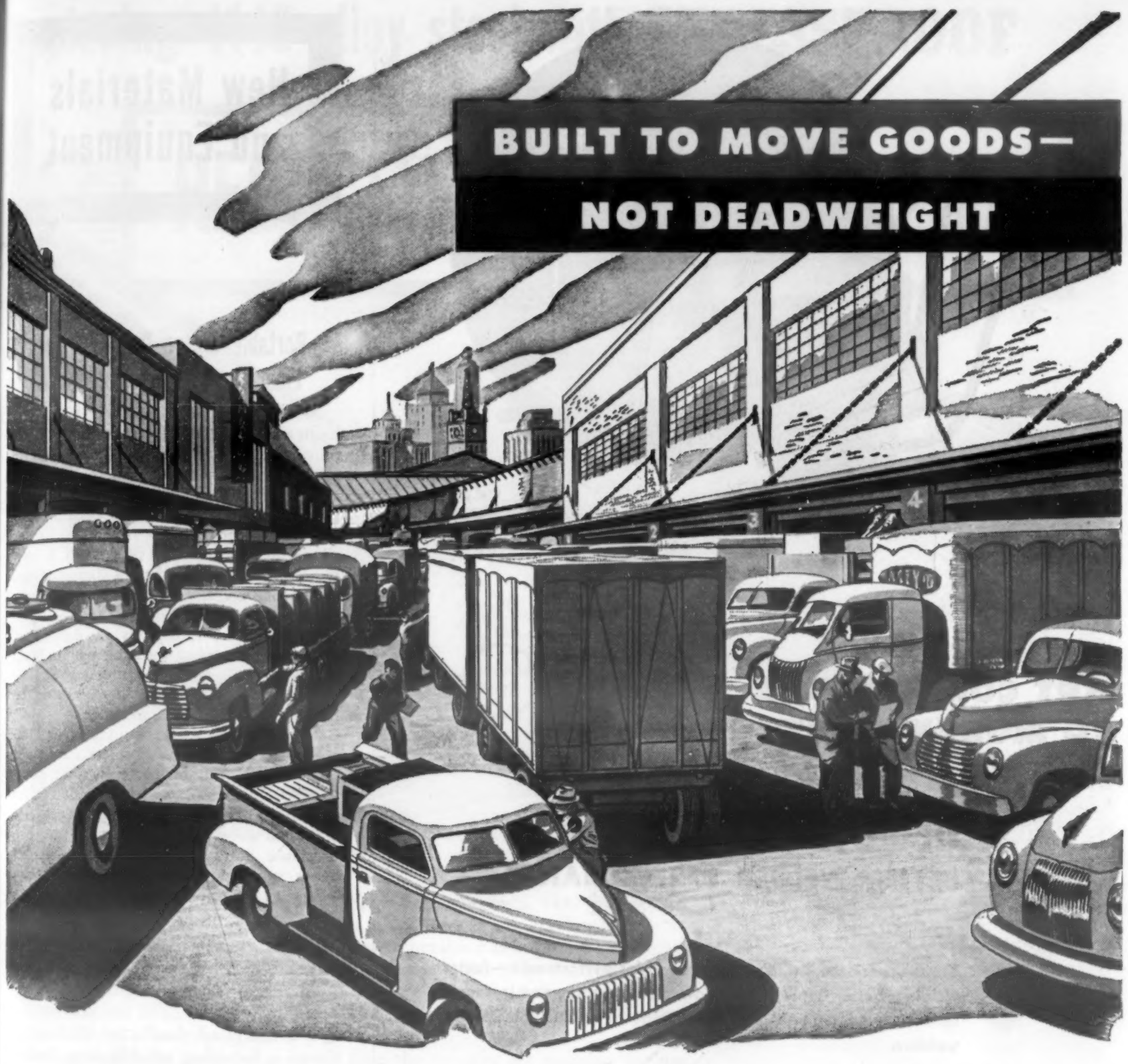
Development of an extremely fine silica pigment by the *Columbia Chemical Div.* of *Pittsburgh Plate Glass Co.*, 632 Duquesne Way, Pittsburgh 22, is claimed to make possible the manufacture of tough, natural and synthetic rubber products, formerly obtainable only in black, in any color desired. Hi-Sil is said to be so fine that 300 million particles will fit on the head of an ordinary pin.

Described as the first practical silica pigment in its field, Hi-Sil is very absorptive. It has a specific gravity of 1.95 and particle size of 0.025 micron as measured by the electron microscope. The pH of the pigment can be varied over a wide range, from about 2.5 to 9.5.

The pigment imparts high tensile strength, good abrasion resistance and high tear resistance to rubber compounds.

Colored Rubber Products Available

Another pigment, similar in nature to that developed by Pittsburgh Plate Glass Co. is being used by *Stalwart Rubber Co.*, 165 Northfield Rd., Bedford, Ohio, to produce rubber products in any color or tone specified.



The weight's in the load and not in the truck when frames, body panels, fenders, wheels and other truck structural parts are made of N-A-X HIGH-TENSILE. And while affording weight savings of up to 25% in section, the high physical properties of N-A-X HIGH-TENSILE insure superior strength and increased resistance to fatigue, corrosion, abrasion and denting.

This decrease in deadweight decreases on-the-job expenses, too. Trucks built with N-A-X HIGH-TENSILE consume less gasoline . . . require less maintenance . . . give longer service. And the excellent formability, weldability, and fine surface texture of N-A-X HIGH-TENSILE mean that you build them better, with no added fabricating problems.

MAKE A TON OF SHEET STEEL GO FARTHER
Specify—
N·A·X
HIGH-TENSILE STEEL

GREAT LAKES STEEL CORPORATION
N-A-X ALLOY DIVISION • DETROIT 18, MICHIGAN
Unit of National Steel Corporation

APT COMPANIONS TO MUREX ELECTRODES-

ENGINEERED TO GIVE YOU BETTER WELDER PERFORMANCE

You'll experience entirely new arc welder performance—faster welding, better quality welds, lower power costs, and less maintenance—with the new, up-to-the-minute M & T AC and DC arc welders.

AC units feature *Built-in Capacitors* for low operating cost... *Fingertip, Stepless Current Control* for precise welding current... *Wide Current Range* plus *Ample Overtravel* for full rated output with long electrode leads. Furnished in 200 to 500 amp models for manual work; others for inert arc and automatic welding.

DC units are *Compact and Lightweight*... half as big and half as heavy as older types... yet are built for full capacity, rugged industrial duty... and are equipped with *Automatic Current Selector*. Available in 150 to 400 amp models—motor-driven, engine-driven, belt-drive.

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METAL & THERMIT CORPORATION

120 Broadway • New York 5, N. Y.

New Materials and Equipment

Portable Meter Designed for Electrolysis, Corrosion Work

M. C. Miller, 1142 Emerson Ave., West Englewood, N. J., has announced availability of a new, small model of the Multi-Combination Meter designed specifically for electrolysis and corrosion investigations and cathodic protection testing in both field and laboratory. Model B is intended for use where the high accuracy of the No. 5 meter is not required, and where a lighter weight, more compact and rugged portable meter is desired.

The new instrument is available with either of two sets of instruments. In Model B-1, the low-resistance voltmeter is 1000 ohms per volt and the high resistance voltmeter is 20,000 ohms per volt. In Model B-2, the low-resistance voltmeter is 3000 ohms per volt and the high resistance voltmeter is 62,500 ohms per volt. Nine ranges from 10 m.v. to 100 v. are provided on the low resistance voltmeter. Six ranges from 0.1 v. to 20 v. are provided on the high resistance voltmeter. A milliammeter/ammeter is provided with nine ranges from 2 m.a. to 20 amp.

● *Wallingford Steel Co.,* Wallingford, Conn., a subsidiary of *Allegheny Ludlum Steel Corp.,* has announced production of 18:8 bright annealed stainless strip steel in widths up to 15 in. This is claimed to be the widest stainless steel strip ever manufactured and is expected to implement fabrication of many items previously unobtainable with this steel.

Recent Developments in Welding Equipment, Controls Announced

Three-Phase Control Improves Weld

A new three-phase, low-frequency control for resistance welding has been announced by *Westinghouse Electric Corp.,* P. O. Box 868, Pittsburgh, Pa. The control is designed to enable a welding transformer to draw power from a three-phase line, convert it to lower frequency single-phase, and supply this to the electrodes of a resistance welder.

Replacing 4140 alloy steel with STRESSPROOF

REDUCED the COST of this shaft 25%

THIS splined drive shaft was originally made from 4140 hot-rolled, normalized, and machine-straightened alloy steel. After cutting to length, the bar was quenched and tempered to a machinable hardness and restraightened. By changing to STRESSPROOF, these quenching, tempering, and straightening operations were eliminated, steel cost was reduced, machining time was cut 33%, and the quality of the part was improved. Over-all reductions in cost afforded a net saving of 25%.

Cost-conscious manufacturers all over the country are realizing savings such as this, and higher . . . because of STRESSPROOF's unique combination of four important qualities *in-the-bar*. STRESSPROOF is twice as strong as ordinary cold-finished shafting and does not require heat treating. Its wearability—*without case-hardening*—is sufficient to replace many heat-treated or carburized steels. In addition, it machines fully 50% better than heat-treated alloys of the same hardness, and, being stress-relieved, it has a minimum of distortion. Yet, with all these advantages, STRESSPROOF costs little more than ordinary cold-finished shafting. It is available in cold-drawn or ground and polished finish.

Stocked by Leading Steel Warehouses

*La Salle**

STRESSPROOF®

SEVERELY COLD-WORKED FURNACE-TREATED STEEL BARS

SEND for FREE

ENGINEERING BULLETIN

"New Economies in the Use of Steel Bars"

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Hammond, Indiana

Please send me your STRESSPROOF Bulletin.

Name_____

Title_____

Company_____

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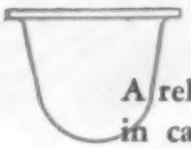
***Manufacturer of the Most Complete Line of Carbon and Alloy Cold-Finished and Ground and Polished Bars in America**

Meehanite®

MELTING POTS

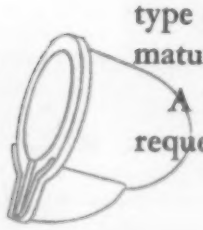
by

Brake Shoe



A reliable and economical source of melting pots is found in castings by Brake Shoe of Meehanite metal. *Reliable* because of Brake Shoe's wide metallurgical knowledge and thorough foundry techniques that protect structural soundness and physical properties. *Economical* because of the longer life expectancy of a sound casting closely matched to its service.

In melting pots, Brake Shoe uses a type of heat-resisting Meehanite chosen to withstand constant heating, intermittent heating and cooling, flame impingement and contact with molten metals. Whether you require the type used for melting aluminum or that for melting lead or zinc, pouring type or holding type, count on these castings to resist premature cracking, warpage, growth, oxidation and corrosion.



A list of available sizes and prices will be sent you on request.

7380

AMERICAN Brake Shoe COMPANY

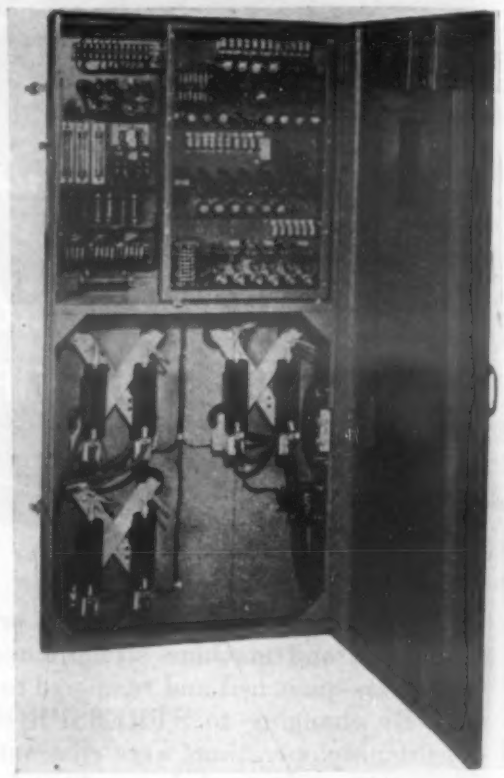
BRAKE SHOE AND CASTINGS DIVISION

230 PARK AVENUE, NEW YORK 17, N. Y.

New Materials and Equipment

An increase in weld quality is claimed as the result of better wave shapes obtained with three-phase control. The three-phase wave favors a smooth flow of heat into the metal.

The high power factor characteristic of low-frequency operation results in reduced KVA demand for any given number of



This new Westinghouse welding control can be mounted on the floor or on the side of the machine.

amperes at the electrodes. The total power demand is spread over all phases of any standard three-phase, 60-cycle, 220-, 440- or 550-volt primary power source.

A complete packaged unit that controls all mechanical and electrical functions of the welding machine is available. It can be mounted on the floor or on the side of the machine. A swing-out panel provides easy access to all components and circuits.

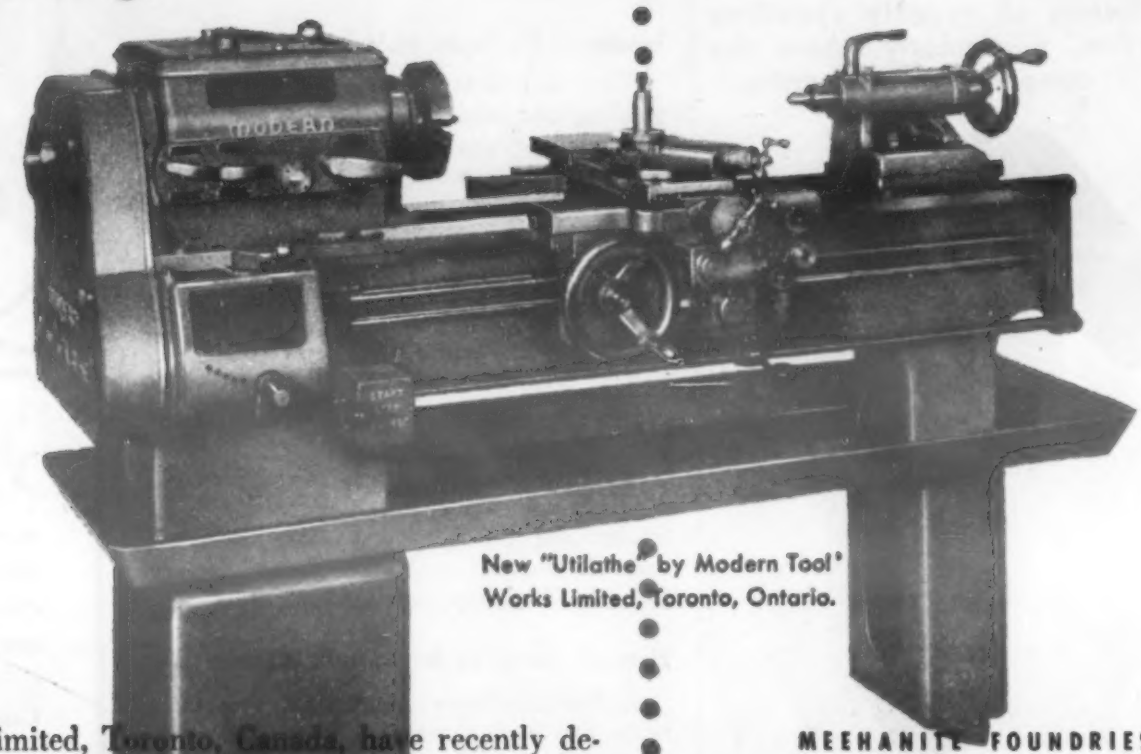
Portable Spot Welder Handles ⅛-In. Steel

A portable spot welder which will weld stainless and mild steel up to ⅛-in. combined thickness is being manufactured by *National Cylinder Gas Co.*

The Sureweld model weighs only 23¼ lb. It operates on 220-v. a.c. lines (25 amp.), single phase, 50/60 cycle. Alternate tongs are available with tips set at 90° or 45° angle, as well as telescopic style which allows maximum reach into hard-to-get-at places.

Designed for intermittent duty, the portable spot welder is adapted for use in garages, auto repair shops and on the farm

Machine Tool Precision Requires MEEHANITE® *Properties and Quality*



New "Utilathe" by Modern Tool Works Limited, Toronto, Ontario.

THE Modern Tools Works Limited, Toronto, Canada, have recently designed and are now producing an entirely new lathe known as the MODERN "Utilathe", illustrated. Machine tools manufactured by this company have acquired a reputation for precision accuracy and maximum performance in production.

From its inception this machine was designed to take full advantage of those engineering properties of Meehanite castings which would contribute to its quality, such as good strength characteristics, maximum vibration absorption, dimensional stability, uniform solidity and good machinability. These castings include:

1. Bed
2. Carriage
3. Cross Slide
4. Compound Slide
5. Headstock
6. Tailstock

Designers of this equipment, like those of many other machine tools "design with confidence" based on their sure knowledge that Meehanite castings over the years provide, regularly and repeatedly, known and established engineering characteristics. Builders of today's equipment rightfully demand this assurance of dependability.

Your product—your new design, can benefit similarly.

For further information write for the Handbook of Meehanite Metals to any of the foundries listed.

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
U. S. Challenge Co.	Centerville, Iowa
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

Meehanite® NEW ROCHELLE, N. Y.

Carburit

PACK HARDENING PASTE

hardens desired sections only

.030 INCHES IN 30 MINUTES

Carburit offers the easiest, quickest method for hardening work when some sections must be left soft. It is a means of greatly speeding production, particularly where the work is complicated and critical.

Here CARBURIT was used to case-harden only the outer surface. Depth of case—.040". Hardness after quenching 65 Rockwell C.

1. Easiest method for section hardening—apply paste only to parts of work that require case-hardening.
2. No special equipment needed. For the first time pack-hardening is possible even where no furnace is available.
3. Not poisonous or toxic.

Order a sample quantity today

Test CARBURIT **Use the coupon**

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CHEMICAL LABORATORIES, INC

172 Pacific St. • Brooklyn 2, N. Y.

Gentlemen: Please send complete information regarding Carburit Pack-Hardening Paste.

Name .....

Title .....

Firm .....

Address .....

.....

New Materials and Equipment

as well as in shipyards, factories and sheet metal shops.

Insulator, Electrode Holder Announced

Two new developments in the field of welding accessories have been announced by *Jackson Products*, Warren, Mich.

One of these products is an insulated arc welding electrode holder of the blade type. Known as Model BT-3, it will take ¼-in. electrodes at 300 amp. It consists of a minimum of easy-to-replace parts and is claimed to be economical, safe and cool-working.

The other development is an improved crown-type jaw insulator now available on this company's entire line of arc welding electrode holders. The insulators are made of laminated fibreglass with melamine binder and other heat resistant material; they are claimed to be five times stronger than the insulators originally furnished.

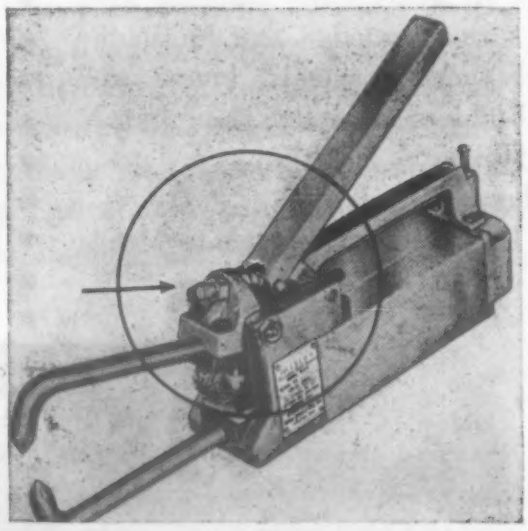
Electrode Designed for Uphand Welding

A fast-solidifying general purpose electrode for steel sheet and plates has been developed by *Eutectic Welding Alloys Corp.*, 40 Worth St., New York 13, especially for uphand welding and "poor fit" joints.

The high burnoff rate of this electrode, known as Eutectrode 6000, is said to make possible use of high currents with resulting increases in welding speeds. The electrode has a hardness of 200 Bhn. and tensile strength of 64,000 to 72,000 psi. It is available in sizes 3/32, ⅛, 5/32 and 3/16 in.

Toggle-Action Lever Used on Spot Welder

An improved portable spot welder with a new toggle-action tong lever has been announced by *Miller Electric Manufactur-*



Easier operation is claimed for this Miller spot welder featuring a patented toggle-action tong lever.

here's what they say about

CrysCoat

for preparing metal surfaces for painting, there is nothing to equal the OAKITE CrysCoat* PROCESS!

YES, painting and finishing superintendents and foremen, process and product engineers, job paint shop-owners, chemists and metallurgists everywhere, are saying good things about the OAKITE CrysCoat PROCESS. They have found that it:

- **cleans metal surfaces and conditions them for painting**
- **improves the adhesion of paint to metal**
- **prevents corrosion before metal is painted**
- **localizes corrosion under paint if finish is scratched or damaged**

and does all these things with minimum equipment . . . in minimum time . . . at minimum cost

FREE Write to Oakite Products, Inc., 32H Thames St., New York 6, N. Y., for illustrated folder F7642 which describes the OAKITE CrysCoat PROCESS and tells how it *cuts cost 10 ways* in preparing metal for painting.

*Reg. U. S. Pat. Off.

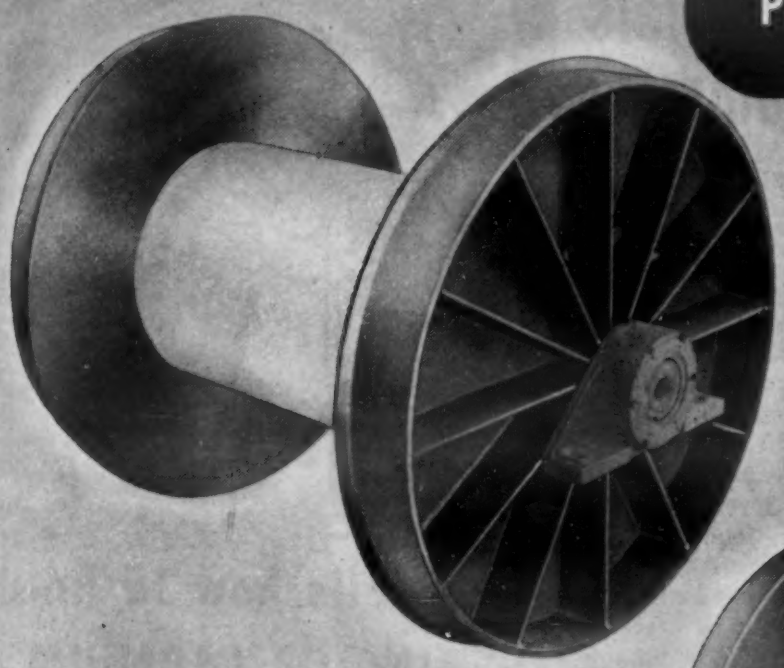
OAKITE

Trade Mark Reg. U. S. Pat. Off.

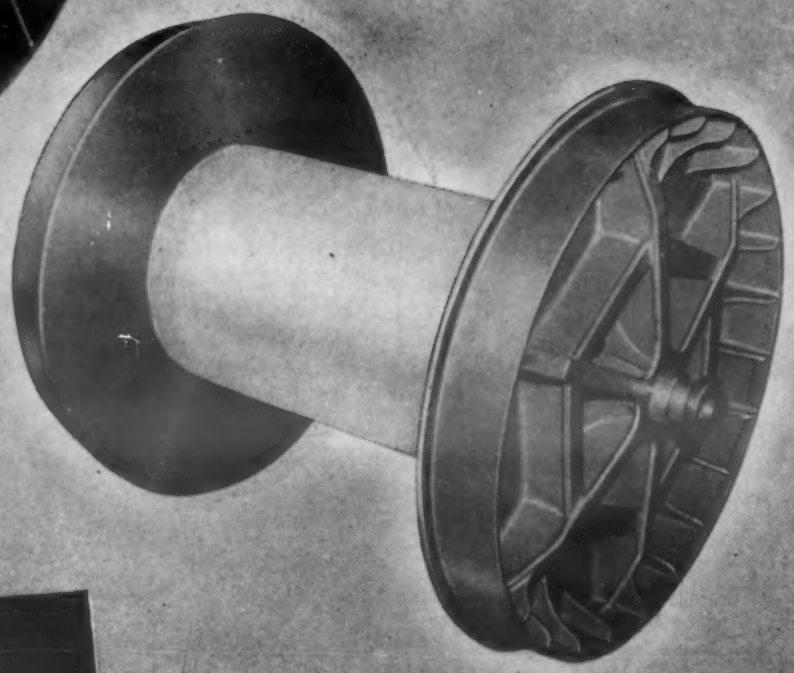
SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

PRODUCT DESIGN STUDIES • NO. 23



FABRICATED FLANGE



CAST STEEL FLANGE

Failures Eliminated Weight Reduced 18% Savings with STEEL CASTINGS

As originally produced, this cable winch flange collapsed on numerous occasions, requiring replacement.

Faced with the problem of finding a way to eliminate these failures—a serious matter in the oil field where this equipment is used — the manufacturer turned to steel castings.

By eliminating the principal cause of failure—lack of rigidity—and by providing high resistance to fatigue and vibration, steel castings gave the degree of dependability required, with a reduction in weight from 1,400 to 1,150 pounds.

Although cost of the part was about the same, manufacturer saved time and money by eliminating storage and maintenance of jigs, fixtures, and templates necessary for fabrication of the part as a weldment.

* * *

Conversion of some of *your* highly stressed parts to steel castings may result in equal if not greater benefits than those given here.

Also in new and redesigned parts, your steel foundry engineer may be able to suggest ways to cut costs and weight and obtain other substantial benefits . . . if you call him in for a discussion *while your product is still on the drawing board.*

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by Steel Founders' Society of America.

STEEL FOUNDERS' SOCIETY OF AMERICA

IRIDITE

gives galvanized parts

2-way RUST PROTECTION

A clean, sanitary appearance and freedom from corrosion are "musts" inside this beverage cooler manufactured by The Vendo Company, Kansas City, Missouri. That's why Iridite was chosen to finish hardware parts and the galvanized vending basket. Iridite stops galvanic corrosion because it forms protective barrier between dissimilar metals. Iridite blocks corrosion from moisture because it seals the metal from contact with condensed moisture.

3 WAYS TO USE IRIDITE

Iridite offers you a complete line of finishes for any zinc or cadmium surface . . . plated, die cast or galvanized, and for any finishing problem . . . corrosion resistance, paint base or eye appeal.

SIMPLE TO OPERATE

You'll find Iridite easy to use, too. It requires no special equipment or personnel, goes on with a short, non-electrolytic dip, dries fast and gives uniformly good results from manual or automatic application.

If you use zinc or cadmium in any form, you can use Iridite. Write today for data and samples, or, send specimens of your product for FREE IRIDITE PROCESSING. *Special note:* Ask about Iridite Bright for zinc or cadmium-plated parts. See how you can get durability and chrome-like brightness at amazing low cost.

ALLIED RESEARCH PRODUCTS, INC.
4004 EAST MONUMENT STREET
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West Coast Licensee—
L. H. Butcher Co., Los Angeles 23, California

New Materials and Equipment

ing Co., Appleton, Wis. The toggle-action unit, which has been patented by the company, is said to make possible greatly increased tong pressure, resulting in better spots and easy operation.

The toggle-action lever is designed to eliminate difficulties found in ordinary lever-type spot welders in exerting sufficient hand pressure to pull together material where fit-up is poor. The lever can be adjusted to either close tight on the work or to pivot past center and lock tight on the work. In this way the operator can close the welder on the material to be spotted, forcing it up tight and locking together, then operate the switch with his other hand. An adjustment is provided between the lever and the tongs to compensate for various thicknesses of metal.

● A new model Thermo Electric Pyrometer, built to indicate temperatures at from one to six thermocouple locations at operating ranges from 75 to 400, 1000, 1600 and 2300 F and from —300 to 300 F, has been announced by *Thermo Electric Co., Inc.,* Fair Lawn, N. J.

New Bonding, Filling Agents Feature Ease of Application

Two new products for bonding of similar and dissimilar materials and correcting porosity in metal parts have been introduced by *Western Sealent, Inc.,* 9042 Culver Blvd., Culver City, Calif. Principal advantage of bonding Agent R-313 and Flawmaster as compared to earlier products of this company is said to be easy manual application without the need of intricate machinery.

Bonding Agent R-313 bonds glass, plastics, neoprene, leather goods, etc., to metals, and ferrous to nonferrous metals, etc. It is claimed to have high resistance to pressure, heat and chemicals.

Flawmaster is a thermosetting compound used to reclaim metal parts and castings otherwise rejected for surface flaws, sand pitting, foundry gas holes, faulty machine surfaces, taps, etc.; it matches the metal to which it is applied. The material is machinable, chemically inert, and heat resistant in a wide range of temperatures.

Free Folder!

--tells how to finish ZINC OR CADMIUM for better CORROSION RESISTANCE ...PAINT BASE

Eye Appeal

If your product uses zinc or cadmium in any form, find out now about Iridite . . . the chemical dip finishes that boost corrosion resistance . . . provide a paint base that defies peeling, flaking, chipping . . . brighten zinc, keeps it bright and free from stains. Write for details today . . . or better still, send samples of your product for FREE processing.

IRIDITE COATINGS *are used on--*

Washing Machine Parts • Radio Equipment
Kitchen Utensils • Aircraft Parts
Lock Hardware • Office Machines
Window Frames • Vending Machines
Wire Cloth • Tools
Lamp Fixtures • Fuel Pumps
Carburetors • Auto Hardware
Zinc Coated Sheet • Hinges, Screws, Bolts
Camera Parts • Plumbing Fixtures
Wall Panels • Refrigerator Parts
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HOW WOULD YOU LIKE YOUR TUBING?

Rare...Medium...Well Done?

(Direct from the Welder) **(Partially Processed)** **(Fully Fabricated)**

The ELECTRUNITE menu is a varied one, including a wide selection of sizes, shapes, analyses, gages, physical properties and surface finishes. From it, you're sure to find the *one* tubing which best meets *all* of your application requirements.

DIRECT FROM THE WELDER TUBING . . . Produced to *your* requirements from either hot or cold rolled steel by Republic's improved electric resistance welding processes. Delivered to you uniformly strong, clean and sound.

PARTIALLY PROCESSED TUBING . . . whether you require a special length, precision diameter or higher than standard physical properties . . . or a combination of these . . . ELECTRUNITE always comes to you as you like it.

FULLY FABRICATED TUBING . . . or, if your product requires a bent, swaged, flared, expanded or tapered part . . . or a completed assembly . . . Steel and Tubes' modern facilities and experienced personnel are prepared to handle the job for you.

See your nearest Steel and Tubes Representative or write *today* for more information.

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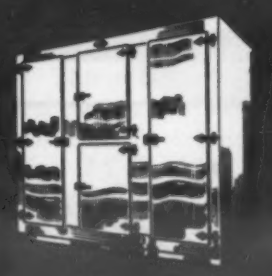
REPUBLIC STEEL
REG. U.S. PAT. OFF.
ELECTRUNITE TUBING

HOW TO MAKE GOOD PRODUCTS BETTER AT NO EXTRA COST...

with PERMACLAD
STAINLESS CLAD STEEL

Truly corrosion resistant!
Easily formed or deep drawn!



The Finer The Finish The Finer The Product For The Finest Finish Use PERMACLAD

PERMACLAD
STAINLESS CLAD STEEL

A Product of ALAN WOOD STEEL COMPANY

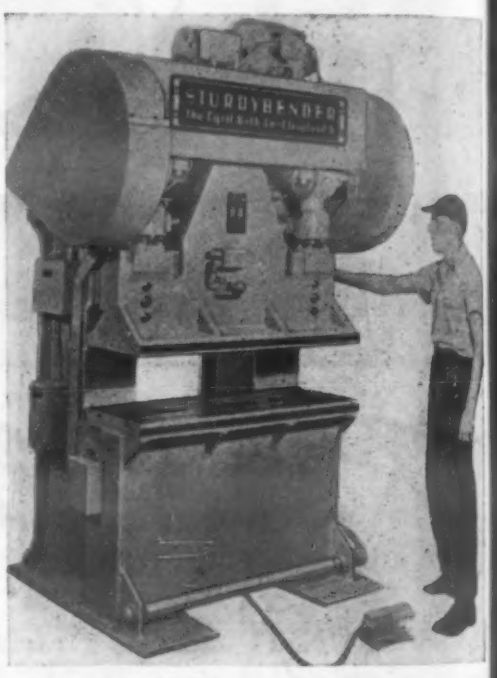
OTHER PRODUCTS

New Materials and Equipment

Line of Press Brakes Features Speed, Wide Bed and Ram Areas

A line of press brakes having wide bed and ram areas and capable of speeds up to 80 strokes per min. has been announced by *Cyril Bath Co.*, 6901 Machinery Ave., Cleveland 3, Ohio.

The new high-speed press is equipped with a safety mechanism which can be used in continuous operation or operated to stop automatically at the top of the stroke. In addition, accidental excessive



Shown here is a 35-ton press brake, one of the new Cyril Bath line. It has a die area of 15 by 42 in.

loads automatically throw out the clutch, preventing damage to press or dies.

The flexible ram setting, low die cost and operator convenience typical of the press brake are claimed for this machine. These high-speed presses are designed as production tools, combining the adaptability of the press brake with the long slides and air clutches characteristic of the conventional press.

● The *Industrial Controller Div.* of *Square D Co.*, Milwaukee 12, Wis., has announced production of a new size OW, 50-amp. welder contactor designed for small spot welding machines up to 10 KVA at 220 v. or 20 KVA at 440 v. High rupturing capacity and longer magnet life are claimed for this controller.

FLAME-RESISTANT

LIGHTWEIGHT

ECONOMICAL

VERSATILE

COLORFUL

TOUGH

Housing is molded in two nesting parts. Pin-point gating reduces finishing operations, yields sturdy pieces free from flow marks. Motor, circulating fan and scent-block assembly are held in place by a metal bracket mounted by means of four metal bushings press-fitted into the plastic housing.

(DISTRIBUTED BY Y & Y DEODORIZER CO., PHILADELPHIA, PA.)

Another Design *First*

attained with "Hercules" Flame-Resistant Acetate

First device of its type to be molded with "Hercules" Flame-Resistant Acetate, the IRO Electric Deodorizer also becomes the the first commercially available model to obtain Underwriters' Laboratories approval.

"Hercules" Flame-Resistant Acetate gives the housing of this unique deodorizer its impact strength, its attractive ivory color, as well as the all-important advantage of a truly self-extinguishing material which can be rapidly injection molded.

Housings and similar applications utilizing "Hercules" Flame-Resistant Acetate are bringing added sales appeal to a growing list of electrical appliances. Our technical staff invites inquiries on improving *your* product with a quality Hercules material.

CELLULOSE ACETATE

"HERCULES" IS REG. U. S. PAT. OFF.

HERCULES POWDER COMPANY

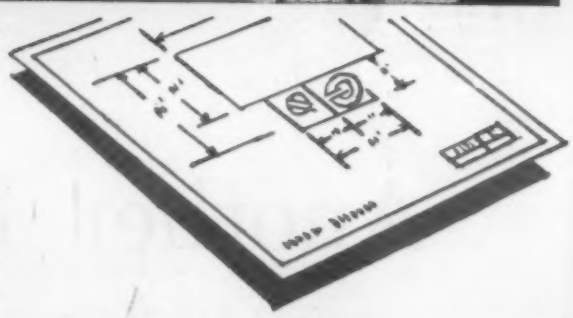
INCORPORATED

996 Market Street, Wilmington 99, Delaware

CP9-8

★ TOP PERFORMANCE WITH AJAX TAMA-WYATT INDUCTION FURNACES for Aluminum Alloys

Ajax Induction Holding Furnace at Mid-Western Die Casting Co., Chicago, Illinois.



★ BETTER PRODUCTION THROUGH TOP PERFORMANCE IS THE AJAX RECORD

Ajax-Tama-Wyatt induction furnaces are used in the United States and abroad for melting and holding aluminum alloys in die casting, permanent mold, and sand foundries.

No flux or mechanical stirring is necessary. The metal is in constant gentle circulation assuring complete blending of alloys, and a uniform temperature throughout the metal.

Electric energy costs less than fuel and avoids danger of overheating. Completely automatic temperature controls hold metal to within 5°F., at the lowest possible temperature for perfect casting. With an Ajax the yield for perfect castings is exceptionally high.

There are no fumes and operation is practically noiseless. Shops are cooler, more comfortable — manpower efficiency is increased. Shop space is increased, for an Ajax Holding Furnace takes an average of 30 to 40 percent less floor space than any other furnace.

The Ajax companies have been pioneers in induction melting of metals since the first World War. To date they have installed more than 400,000 KW. of furnace capacity in the United States alone. This is the background of experience behind every Ajax installation.

AJAX ENGINEERING CORPORATION • Trenton 7, New Jersey

AJAX TAMA-WYATT INDUCTION MELTING FURNACE

Associate Companies: **AJAX METAL COMPANY,** Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORP., Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

New Materials and Equipment

Magnesium-Ferrosilicon Alloy Aids Nodular Graphite Formation

Formation of nodular graphite in cast iron is promoted by a new magnesium-ferrosilicon alloy available from the *Electro Metallurgical Div.* of *Union Carbide & Carbon Corp.* The alloy contains about 7 to 10% magnesium, 43% silicon and the balance is mainly iron. It is available in the standard size of ⅜ in. and smaller.

The hazards of a magnesium addition are said to be minimized when this magnesium-ferrosilicon alloy is used to produce nodular iron. Only one ladle addition is required, as the alloy acts both as a nodulizing and an inoculating agent.

● A compound spreader, which automatically applies drawing compounds to sheet metal, is being produced by *Union Tool Corp.,* Warsaw, Ind. Models are available to fit any size stock up to 96 in. wide.

Crank, Hydraulic Press Design Changed to Meet New Standards

New lines of straight side single and double crank presses, and single and double action hydraulic presses have been developed by *E. W. Bliss Co.,* 1420 Hastings St., Toledo 7, Ohio, in conformance with recently established standards of the Joint Industry Conference.

For the single and double crank presses, these standards provide slightly larger tonnage and weight capacities and bend and slide areas than former standards. Important features of the new presses are: "box" type crowns and slides reinforced by deep internal ribs; barrel type slide permitting long adjustment to accommodate dies varying greatly in height; four-piece Meehanite tie rod construction of all press frames; longer slides and gibs for precision grinding of die work; power adjustment of slide; and pneumatic friction clutches mounted on the crankshaft of single end drive presses up to 250 tons.

A 650-ton single action press, first of the new hydraulic line to be produced, is claimed to provide lower initial cost, lower maintenance cost, smoother and quieter operation, and increased production. Design changes on this press include: simplified circuit and use of dual flow pumping

1/3

800

ASK FOR THESE BULLETINS

TECHNICAL BULLETIN No. 126
DATA BOOK No. 107
GAS BOOSTERS No. 109
FOUR BEARING No. 110
BLAST GATES No. 122
FOUNDRIES No. 112

You may not need an 800 HP Turbo-Compressor but it is interesting to know that this Spencer machine is delivering large volumes of air at 10 lbs. pressure for engine testing.

The midget Spencer delivers 85 cubic feet per minute at 8 ounces pressure and is used by the hundreds by manufacturers of heat treating, air conditioning and pneumatic tube systems as a part of their finished products.

The Spencer Turbo is distinguished by its simple, sturdy construction, with constant pressure automatically delivered with high efficiencies at all loads.

Quiet operation without vibration is one of the advantages of the Spencer Turbo. This is due to several factors: the multi-stage construction resulting in low peripheral speeds; lightweight perfectly balanced impellers with wide clearances; and a ball bearing supported by a cast bridge work.

SPENCER TURBO APPLICATIONS

AGITATION • HEAT TREATING • GAS BOOSTERS • VENTILATION

Standard sizes from 35 to 20,000 cu. ft.; 1/3 to 800 HP ; 8 oz. to 10 lbs. Single or multi-stage, two or four bearing. Special gas-tight and non-corrosive construction available. Ask for the Turbo Data Book and Bulletins.

359-C

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONN.

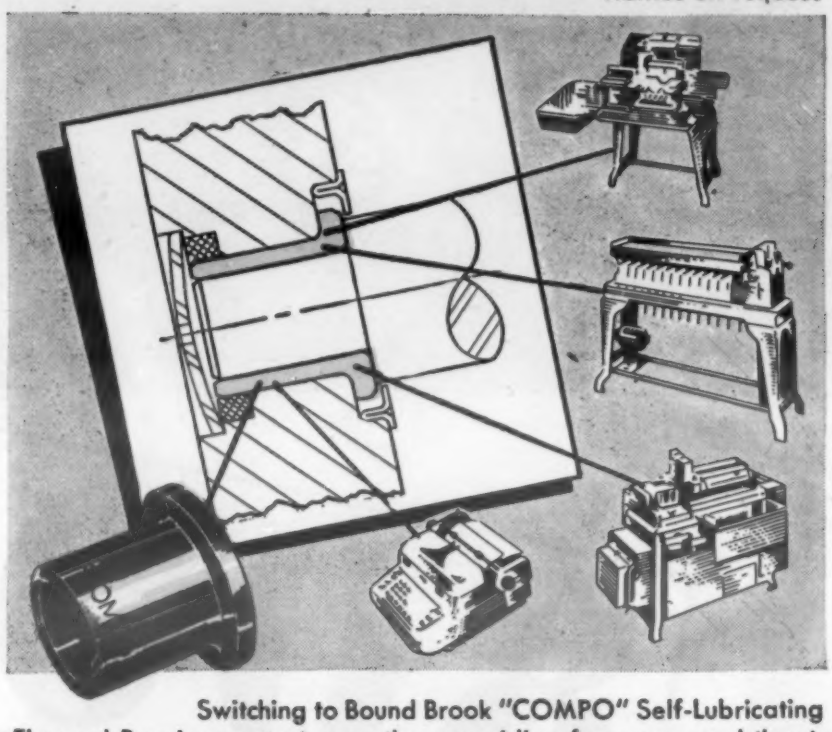
SPENCER HARTFORD

TURBO-COMPRESSORS

"COMPO" OIL-RETAINING POROUS BRONZE BEARINGS

Why Nationally-Known Business Machine Manufacturers* Use "COMPO" SELF-LUBRICATING BEARINGS

*Names on request



Switching to Bound Brook "COMPO" Self-Lubricating Flanged Bearings meant more than providing for severe end thrust. It meant:

To the manufacturers:

- *Simplification of design, quicker, lower cost assembly and elimination of costly machining operations.*

To end users:

- *No periodic lubrication, maintenance costs cut, and continuous, quiet, trouble-free operation.*

"COMPO" Porous Bronze Bearings are made from pure metal powders, die-formed to shape, alloyed at high temperatures, finished to exact dimensions, and vacuum-impregnated with lubricant. Self-lubricating qualities make them ideal for use in inaccessible spots. The lubricant is sealed in, free from dirt, and an even lubricating film is always present.

Thousands of "COMPO" Bearing sizes can be made from existing dies; hundreds of sizes in stock for prompt shipment. Use coupon below, to get our free Stock List or arrange a conference with one of our engineers. *We've saved time and costs for others, we can do the same for you.*

Many other types of "COMPO" Bearings and "COMPO" structural parts have been designed into business machines, appliances and other types of equipment at equal savings and with equal performance benefits.

BOUND BROOK OIL-LESS BEARING COMPANY

BEARINGS • BUSHINGS **WASHERS • PARTS**

BOUND BROOK, N. J. **ESTABLISHED 1883**

Bound Brook Oil-Less Bearing Co.
Bound Brook, N. J.

MM 11-48

☐ I would like to talk to one of your engineers about_____

☐ Please send me a copy of your "COMPO" Bearing Stock List.

Name_____ Title_____

Company_____

Street_____ City_____ State_____

New Materials and Equipment

system; major reduction in amount of piping and valves; unit design of frame, cylinder and slide; prestressed tie rod frame; four adjustable flat type Meehanite gibs with removable wear strips on uprights; foot valve directly connected to cylinder; no interconnecting piping; open type prefill valve; and pump design which permits reversing of oil flow and provides controlled

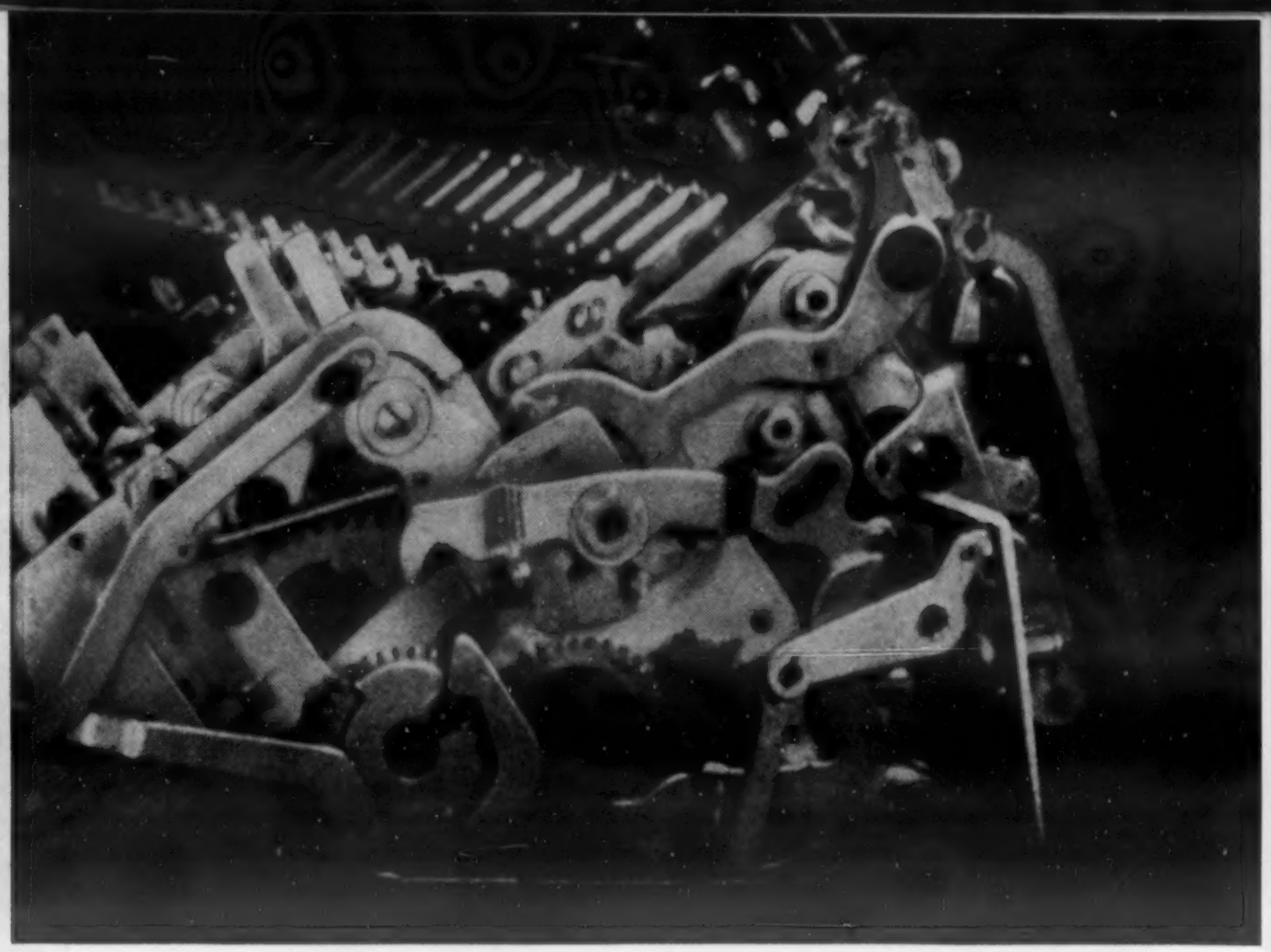
This 150-ton press is the first of the new design Bliss straight side single and double crank line.

gravity descent with smooth starting and stopping as well as smooth release of pressure at end of stroke.

The Bliss presses are used in metal working for blanking, cutting, punching, shaping, stamping and embossing. Equipped with Bliss Marquette Die Cushions, they can be employed for a considerable range of drawing and forming work.

Reverberatory Tilting Furnaces Have Wide Range of Capacities

Reverberatory tilting furnaces of the Sklenar type for the melting of ferrous and nonferrous metals are now available from *Bellevue Industrial Furnace Co.*, 2971 Bellevue Ave., Detroit. The self-contained units range in capacity from 350 to 20,000 lb.,



Frames of movie film, taken with Kodak High Speed Camera, show a desk-type calculating machine performing automatically at five hundred r.p.m.

Now high speed movies with good depth of field

TODAY high speed movies provide the research scientist with more detailed information than ever. For with the Kodak High Speed Camera, these pictures are sharp and clear and in addition have remarkably good depth of field.

This is due both to the high intensity lighting now available and to the high-quality optical system which employs a rotating, accurately plane-parallel glass plate behind the lens to sweep the image in synchronism with the traveling film.

In the example illustrated, the camera was operating at 2000 frames per second with a lens aperture of *f*/8. Illumination of 7 to 15 times the intensity of sunlight on a bright day was provided by the new General Electric 750R Reflector Photographic Lamp.*

If you would like more information about the Kodak High Speed Camera, just mail the coupon. Eastman Kodak Co., Rochester 4, N. Y.

*This lamp may be ordered from your local Kodak dealer.

the Kodak *High Speed* Camera

54

EASTMAN KODAK COMPANY, Rochester 4, N. Y.
Gentlemen:
Please send me: ☐ your folder "Magnifying Time" which describes the High Speed Camera; ☐ a 16mm. sample reel of high speed motion study which I may borrow.

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Cut Polishing Time Improve Surface Quality

with "LINDE" FINE ALUMINA POWDERS

Now, you can choose the type of finish you want, free from microscopic pits and scratches, on metallic and non-metallic surfaces. And you can get these superior results in a fraction of the usual polishing time by using ultra-fine LINDE abrasive powders.

Because of extremely uniform particle size and form, smaller amounts of LINDE Fine Alumina Powders go further. You can use them directly from the container without expensive preparatory steps—or compound them with waxes and other vehicles to suit your need.

Two types are available. Type A is a quick-acting powder of hexagonal structure and sapphire hardness. Type B produces a still finer polish, almost as quickly.

LINDE Fine Alumina Powders may be the answer to your polishing problems. They have already gained acceptance in polishing metallographic specimens, gemstones, and other materials. Call or write any LINDE office to find out how these powders can be used to advantage in your particular polishing applications.

The term "Linde" is a trade-mark of The Linde Air Products Company

	Type A	Type B
Chemical Composition	Alpha Al_2O_3	Gamma Al_2O_3
Particle Size (approximate)	0.3 Micron	Less than 0.1 Micron
Hardness (Mohs) (Equivalent to crystalline material)	9	8
Crystalline Structure	Hexagonal	Cubic

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

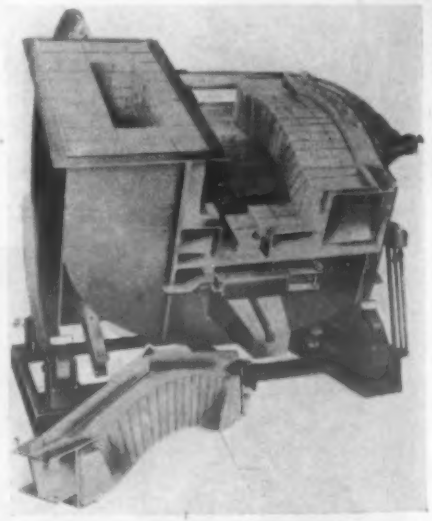
New Materials and Equipment

and can produce 13 to 21 melts per day.

Sklenar type melting furnaces are readily accessible for skimming, refining, alloying and inspection during the entire melt. The type of tilting mechanism is governed by the size of furnace; hydraulic or compressed air automatic tilt is available for furnaces with capacities over 1000 lb. of brass, whereas furnaces of less capacity are hand tilted.

The metal is charged through a hopper which also serves as outlet for exhaust from the combustion chamber. The pre-heated metal is melted in the hopper; it then trickles down into the metal bed. Continuous charging can be maintained using borings, spillage or almost any other form of metal, as well as ingot metal.

Fast melting and fuel economy are



Shown here is one of a new line of Sklenar-type melting furnaces manufactured by Bellevue Industrial Furnace Co.

achieved by using the same fuel to heat the combustion chamber that is used to melt the metal in the hopper. The unit is fired with oil or gas and draft is supplied by a blower, which is part of the furnace. Atmospheric conditions in the combustion chamber are closely controlled to eliminate occluded gases.

● *Bee Chemical Co.*, 13799 South Ave. "O", Chicago 33, has developed a new material which makes it possible to provide a white coating on a phenolic plastic surface with a single application and air drying. Identified as Phenolic White Coating R-1319, the product is claimed to be suitable wherever extremely high gloss is not needed and wear conditions are not too severe.

NEW and EXCLUSIVE developments in induction heating...

Available in single and two-station models the Lindberg LI-25 is ideal for hardening, brazing and soldering, annealing and stress relieving, hot forming and light forging, shrink fitting and other induction heating applications.

The Lindberg LI-25 is a ruggedly constructed vacuum-tube type unit for hard working production line jobs. Oscillator tube, power transformer and other major components deliver a full 25 KW with plenty of reserve to insure dependable day in and day out performance. Well designed—safe and simple to operate—featuring the most desirable developments in high frequency heating.

CONDITIONED COOLING—Built-in to increase tube life, eliminate harmful condensation and scaling, reduce water pressure and consumption—can be used with hard water. Rubber hoses are completely eliminated.

"CHECKLITE"—a unique feature exclusive with this unit, makes servicing easier, reduces maintenance costs.

AUTOMATIC CONTROL—when job cycles are set, automatic timer controls every phase of the operation—heat, quench, fixture movement.

SAFE AND SIMPLE—both operator and operating parts are protected—filament voltages are constantly regulated—tank capacitor is hermetically sealed—work coils protected against burn out. Every unit certified to meet FCC regulations. For detailed information write for Bulletin T-1420.

LINDBERG HIGH FREQUENCY HEATING

A DIVISION OF LINDBERG ENGINEERING CO.

2451 West Hubbard Street, Chicago 12, Illinois

YES, Ace hard rubber literally knocked the stuffings out of the arm for this chair. Formerly a padded, upholstered metal stamping bolted to the chair frame, it's now a one-piece, indestructible hard rubber molding, with leather-grain finish, and a feel that's just right.

What's more, it's assembled to the chair in a jiffy. You simply slide a headed insert into a slot, flex the rubber around the curve, and run up two screws from underneath.

You too may find "a better way" in one of the many Ace hard rubber or plastics molding and extruding compounds.

If you would like to know more about these Ace materials—where used—properties—design hints, etc., just write on your company letterhead for the new free 60-page Ace Handbook.

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HARD RUBBER and OTHER IMPORTANT PLASTICS
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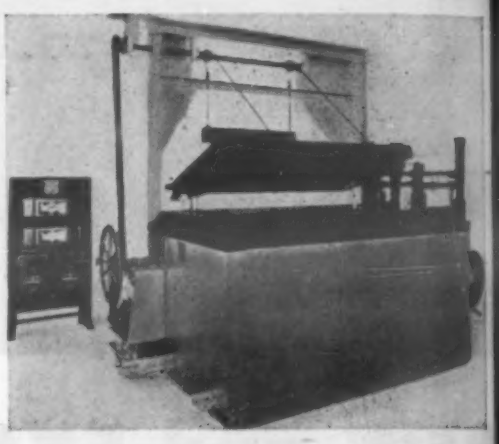
New Materials and Equipment

Portable Gas-Fired Salt Bath Descales Stainless Steel Parts

A portable gas-fired salt bath for descaling processes on stainless steel parts is being manufactured by *James H. Knapp Co.*, 839 E. Fourth St., Los Angeles 13. It can be fired with natural, artificial or any of the low-pressure gases. The welded steel bath, which operates about 930 F, is heated



This Knapp salt bath can be operated on natural, artificial or any of the low-pressure gases.

by two immersion tubes equipped with air-operated eductors to insure proper travel of gases.

The unit is encased in a heavy insulated steel shell. A motor-driven hinged lid covers the top and is arranged with limit switches and up-and-down push-button station; it can also be operated manually. All burners are electrically ignited and have flame failure cutouts. Heat is regulated by automatic temperature controls.

Zinc Alloy Die Castings Ejected More Easily with New Lubricant

Non-toxic Die Slick No. 9, a lubricant which prevents scoring and sticking of pressure die casting dies and enables easy ejection of castings from the die, is being manufactured by *G. W. Smith & Sons, Inc.*, 5400 Kemp Rd., Dayton 3, Ohio.

Applied with brush or spray, the lubricant does not stain and is claimed to assure a good surface finish on the casting. The compound leaves no carbon, gum or other residue in the die. The company recommends this lubricant especially for zinc alloy die castings that are to be plated, *e.g.* automotive hardware.

WE TAKE OUR RESPONSIBILITY SERIOUSLY

•

THE DOEHLER-JARVIS CORPORATION is the world's largest producer and finisher of die castings. That record has been built on four basic principles—

QUALITY • INTEGRITY • DEPENDABILITY • SERVICE

Recognizing the responsibility that goes with our leadership in the die casting industry, we are dedicated to build our future on those same basic principles.

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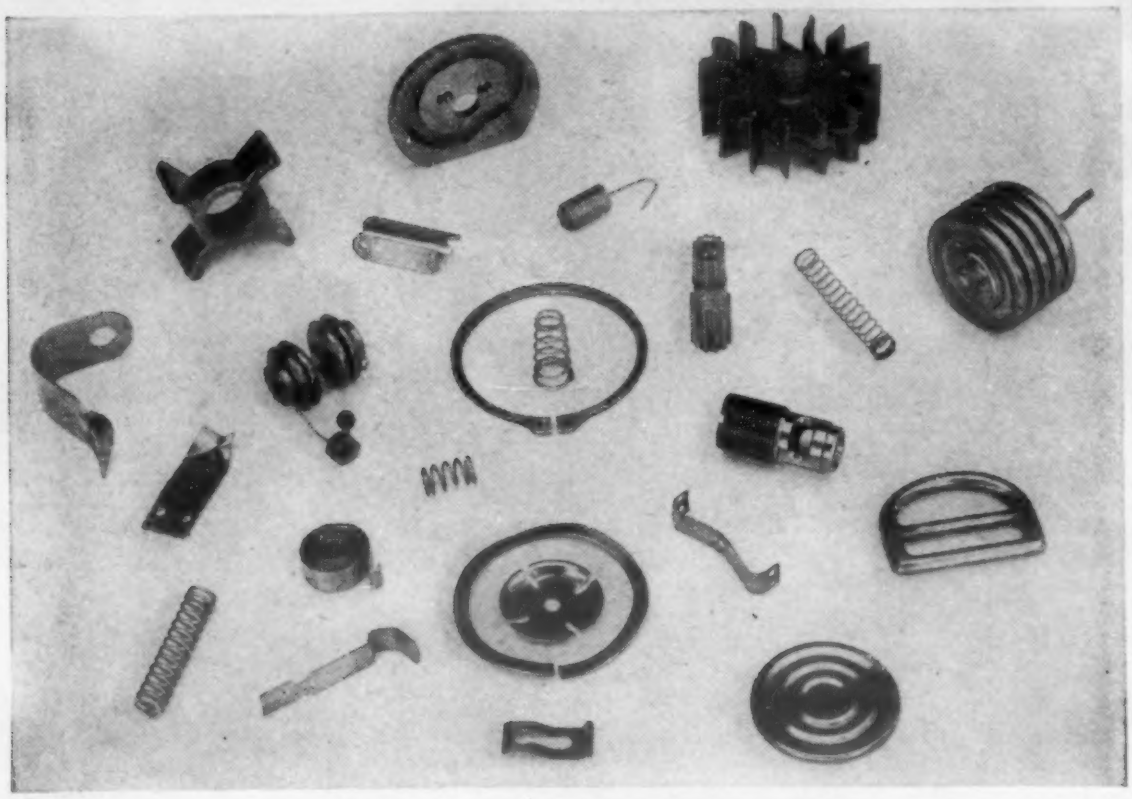
Where Performance Counts—
Look to **BERYLLIUM-COPPER**



Dollar-conscious designers are saving money by considering the following factors which influence the over-all cost picture.

- **DESIGN** — Beryllium-copper's high strength makes possible smaller parts and lighter sections. This means important cost savings through smaller units, increased sensitivity and added flexibility of design.

- **FABRICATION** — Through heat-treatment beryllium-copper offers economies in fabricating severely formed parts requiring good strength. Parts are readily machined or formed in the unhardened condition, then hardened to maximum properties by a simple, low-temperature heat-treatment followed by uncontrolled cooling. For example, annealed BERYLCO 25S strip withstands the severest forming and reaches an ultimate tensile strength of 175,000 psi after heating for three hours at 600°F. Where less forming is required, cold-rolled tempers give correspondingly higher tensile values.
Also, absence of grain direction in moderately cold-worked strip permits efficient use of stock.

- **INSPECTION AND ASSEMBLY** — Uniformity of parts over large production runs reduces rejects and inspection costs, permitting spot checking instead of 100% inspection. Where necessary, fixture hardening insures dimensional control to a degree not otherwise obtainable and eliminates expensive hand adjustment during assembly.

- **MAINTENANCE** — Positive action as measured by resistance to relaxation and drift offers savings through less frequent calibration and reduced labor charges. These features are of particular significance in contacts, diaphragms and instrument springs. The stability of beryllium-copper prevents loss of tension in electrical contact springs, the cause of frequent adjustment in the field.

- **REPLACEMENT** — High elastic and endurance strength, together with excellent resistance to corrosion and wear, means longer life with increased efficiency through fewer breakdowns, preventing disruption of vital services. In addition, part failure may lead to replacement expense many times greater than the expected saving through specifying a cheaper material. This is particularly true for cams, springs, bushings and similar inconspicuous parts on whose faithful service depends the continuous operation of complex machinery. In such applications, beryllium-copper frequently offers the lowest cost answer.

Write today for literature, or if you have a design problem send us full information with a drawing or sample of the part.

BERYLCO BERYLLIUM

The **BERYLLIUM CORPORATION**

Dept. 5, Reading 3, Pa.

New Materials and Equipment

Permanent Magnet Materials Have High Induction, Coercive Force

General Electric Co., Pittsfield, Mass., has developed two new permanent magnet materials, Alnico 5 DG and Alnico 7.

Alnico 5 DG is a modification of Alnico 5 in which the crystal structure of the magnet is aligned in the direction of magnetization ("DG" refers to "directional grain"). As a result of this modification, smaller magnets can be used to do the same job larger magnets formerly did. This in turn makes possible a reduction in the size and weight of loud speaker magnetic frames and corresponding cost reductions. This new product is claimed to have the higher external and residual induction of any permanent magnet material known.

Alnico 7 has been developed specifically for applications where a high demagnetization force is present, as in motors, generators and variable air gap devices. This magnet has greater coercive force than any other grade of Alnico.

● An air draw muffle furnace for tempering tool and die steels at temperatures up to 1250 F is being produced by *Hevi-Duty Electric Co.*, Milwaukee, Wis. Uniform heating is promoted by a baffle which directs air from a high-speed centrifugal fan through a narrow passage between the heating elements and the baffle, then into the work chamber and back to the fan intake.

Injector Produces Wax Patterns for Industrial Precision Castings

A heavy-duty injector designed specially for volume production of wax patterns for industrial precision castings has been introduced by *Alexander Saunders & Co.*, New York City.

In the Sherwood Wax Injection Press the wax is extruded by direct piston drive activated by a hydraulic pump. Wax pressure may vary from 100 to 1500 psi. The wax is contained in cylinders carried in a revolving drum; while the wax is being discharged from one cylinder, the wax in

Take Your Pick of these Allegheny Ludlum Booklets on

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WHY is stainless steel equipment becoming so increasingly important? WHAT are the specific applications? HOW about grade selection, corrosion resistance, forms available, and fabrication?

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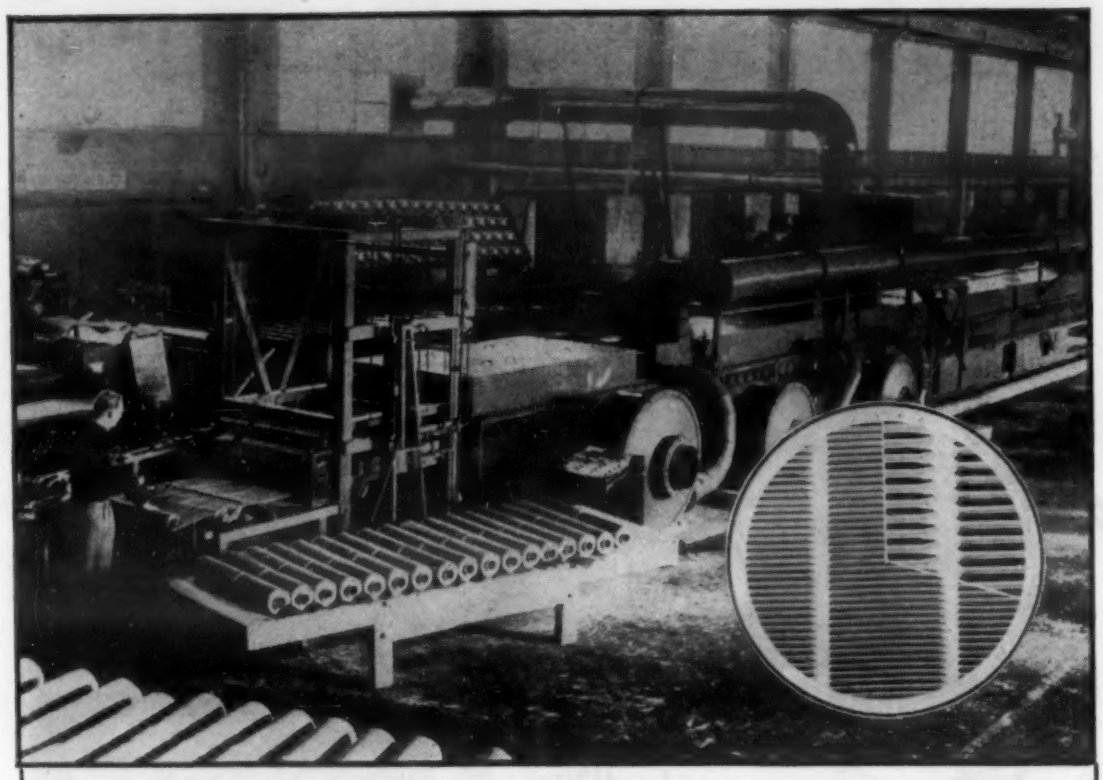

The Alodizing installation at Permanente's Trentwood, Washington plant. Kaiser Aluminum Shade Screening (shown in inset) excludes insects and, venetian-blind-wise, deflects the rays of the sun thus reducing room temperatures as much as 15° F. without interfering with air circulation.

This screening is produced by the Permanente Metals Corporation and sold by Permanente Products Company to screen manufacturers, distributors and dealers throughout the nation.

Alodized* **ALUMINUM**
provides
Kaiser Aluminum **SHADE SCREENING**
WITH MAXIMUM PROTECTION

Kaiser's new departure in screening, shown above, utilizes "Alodine"—the new development in metal protection. "Alodine" greatly increases the natural weather resistance of aluminum and reduces reflectivity by masking aluminum's metallic luster with a pleasing shade of green.

Alodizing is a purely chemical process—not an electrolytic one—and involves no elaborate apparatus. The coating solution is applied rapidly, uniformly and at low cost. Spray, dip, and even brush processes make Alodizing available to all kinds of installations; and manufacturers of aluminum are Alodizing on a huge scale at their mills to supply Alodized sheets and coils to plants lacking facilities for treating the metal.

"Alodine" promotes economy in production; and protects the quality of finished aluminum products. Insist on Alodizing and Alodized aluminum in your own fabrication. Write to us for further information on "Alodine".

* "Alodine" Trade Mark Reg. U. S. Pat. Off. by The American Chemical Paint Company.

CHEMICALS ACP PROCESSES

RUST PROOFING AND PAINT BONDING
Granodine *
Duridine *
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AMERICAN CHEMICAL PAINT COMPANY
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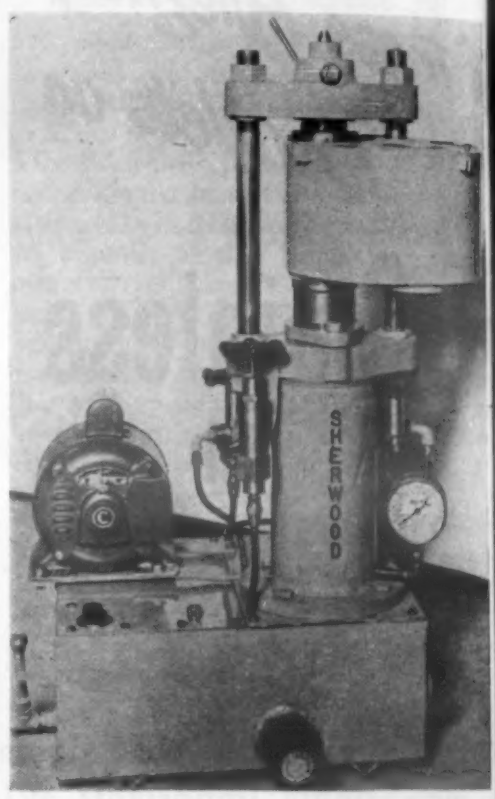
New Materials and Equipment

the other cylinders is being tempered for future use. This arrangement makes it possible to shift a new full cylinder quickly into position after a cylinder has been



Pressures from 100 to 1500 psi. are used in this Sherwood Wax Injection Press.

emptied. Each wax chamber has a capacity of 78 cu. in. The double-acting hydraulic pressure piston has a diameter of 4 in. and an effective stroke of 8 in.

The wax temperature, which can go as high as 400 F, is controlled thermostatically within ±2 deg. F of the desired temperature.

Rubber-Like Plastics Possess Improved Corrosion Resistance

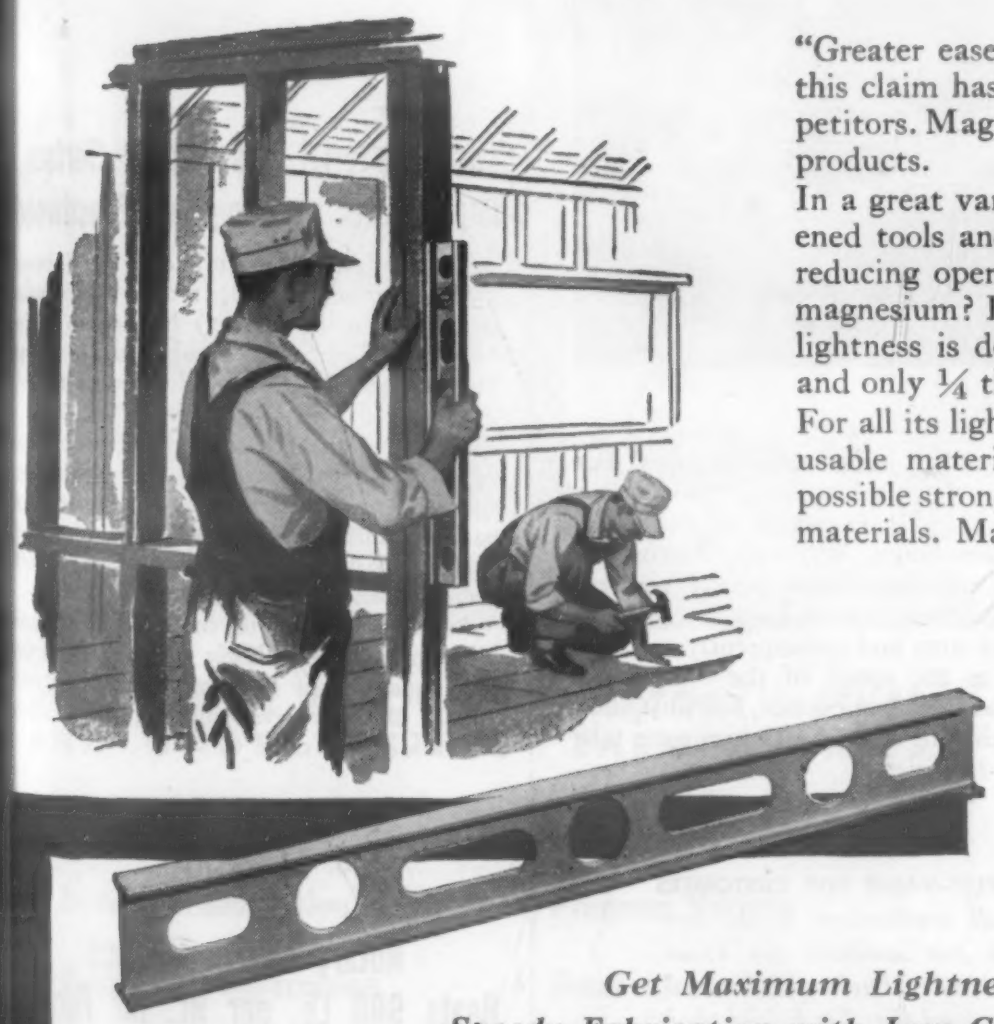
Rubber-like plastic materials, said to possess many chemical properties lacking in both natural and synthetic rubbers, have been developed by the *Organic Coatings Div.*, of *United Chromium, Inc.*, 51 E. 42 St., New York 17. Known as Unichrome Plastisol and Organosol Compounds, these materials are easily handled, possess high dielectric strength, and have high resistance to abrasion and to a wide variety of chemicals and corrosives.

The materials are available in paste-like form, Plastisols containing 100% solids and Organosols containing a small amount of

Noticeably greater ease in use comes with products made of Dow

MAGNESIUM

the world's lightest structural metal!



"Greater ease in use"—the product that can substantiate this claim has a tremendous sales advantage over its competitors. Magnesium has given this sales advantage to many products.

In a great variety of industrial fields magnesium has lightened tools and equipment, making them more efficient by reducing operator fatigue and increasing his output. Why magnesium? Because magnesium is the logical choice when lightness is desired. It's a full ⅓ lighter than aluminum, and only ¼ the weight of steel.

For all its lightness, magnesium is a remarkably strong and usable material. Its high strength-to-weight ratio makes possible strong, rigid designs with weight savings over other materials. Magnesium is readily available in all common forms and is easily and economically fabricated by well established shop procedures.

To see case studies showing how magnesium has improved products in many different fields, write for your free copy of "How Magnesium Pays."

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New York • Boston • Philadelphia • Washington • Cleveland
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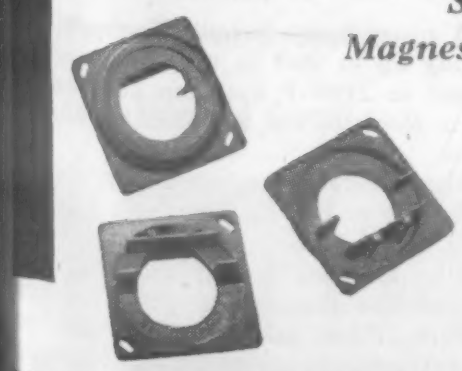

Get Maximum Lightness, Speedy Fabrication with Low Cost Magnesium Extrusions and Die Castings

Wise manufacturers like the maker of this carpenter's level are profiting from the combined use of magnesium extrusions and die castings. Low cost magnesium extrusions are used to replace more costly formed or fabricated sections, while die cast magnesium parts greatly reduce the machining required because of their good surface finish and excellent dimensional accuracy.

Lighter Products Sell—make your product Magnesium Light

new aircomatic process does three hours' work in fifteen minutes

MARTIN-QUAID COMPANY, a prominent metal fabricator of Philadelphia, Penna., received the job of constructing a number of special aluminum vessels from the IN-TAG Division of Interchemical Corporation. The established method of production seemed too costly of both time and money.

Dana V. Wilcox, Airco Technical Sales Representative, recommended the *new* Aircomatic Process with Airco Helium. Aluminum alloy ½" and ¾" thicknesses was used. The suggestion was adopted, and the process was applied to the job on a production basis.

Prior to the introduction of the new Aircomatic Process, Martin-Quaid used another arc welding method, but found welding time to be a disproportionate amount of its manufacturing costs. For example, the total welding time for a 4′ x 5′ x ½" side section of the vessel took three hours. With the Aircomatic Process, the three-hour period was reduced to fifteen minutes — a tremendous saving in time and consequently cost.

Due to the speed of the Aircomatic Process as a production tool, Martin-Quaid is planning to expand its aluminum fabrication facilities.

• • • •

TECHNICAL SALES SERVICE — ANOTHER AIRCO PLUS-VALUE FOR CUSTOMERS

To assure its customers of high efficiency in all applications of the oxy-acetylene flame or electric arc, Air Reduction has available the broad, practical experience of its nationwide Technical Sales Division personnel. The collective experience and knowledge of these specialists has helped thousands to a more effective use of Airco processes and products. Profit by this Airco "Plus-Value" service. Ask to have a Technical Sales Division man call today. Write: Your nearest Airco office. In Texas: Magnolia Airco Gas Products Company. On West Coast: Air Reduction Pacific Company.

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New Materials and Equipment

liquid solvent or diluent. The plastics can be molded or applied as coatings to metal, fabric or paper by dipping, spraying or brushing; a single application will produce coatings from 0.003 to 0.25 in. thick. Upon baking 20 to 30 min. at 350 F, the materials set and assume a rubber-like appearance.

The cured compounds resist acids, alkalis, salt solutions, oils, gasoline, greases, industrial oxidants, and a number of other types of chemicals and products normally corrosive to rubber. They have been used on pipes, tanks, drums, work carriers, tool handles, cotton gloves, protective clothing and process equipment.

New Material Has Plastic Surface Impregnated on Tempered Presdwood

Lamidall, consisting of a tough stainproof plastic surface (comparable to popular laminates on the market) bonded to ⅛-in. Masonite Tempered Presdwood, is being manufactured by *Woodall Industries, Inc.*, 2025 S. Calumet Ave., Chicago 16, Ill.

The new material is made in panel sizes up to 4 by 12 ft. and can be fabricated to specification in desired shapes or sizes for parts or finished products. It can be sawed, shaped, nailed, punched or drilled with standard wood working tools.

Lamidall is said to combine the wearability of a tough plastic surface, the structural qualities of Presdwood, and the eye-appeal of distinctive patterns, solid colors and wood grains.

Rotary Hearth Furnace Heats 900 Lb. per Hr. for Forging

A rotary hearth furnace capable of producing up to 900 lb. of forgings per hr. heated to 2100 F has been developed by *W. S. Rockwell Co.*, 200 Eliot St., Fairfield, Conn.

The furnace atmosphere is carefully controlled to produce a light scale that will flake off easily with the first blow of the forging hammer. This is accomplished by gas burners designed to permit a slight amount of fuel oil to be introduced into the furnace atmosphere during the heating operation. Usual heating time is from 12 to

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The New MODEL 1300 Wheelco
FLAME-OTROL
The New, Dependable Combustion Safeguard for Oil and Gas Fired Furnaces, Ovens, Boilers, Kilns and other Heating Equipment.
Safe-Start • Safe-Operation • Safe Shut-Off
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Read the Facts About the New Model 1300 FLAME-OTROL

Learn... how the Wheelco FLAME-OTROL now renders more positive and dependable protection to all types of gas and oil fired heating equipment from safe-start to safe shut-off:

...how the many new protective features of this improved Wheelco FLAME-OTROL give you a Combustion Safeguard—"safer than ever."

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- ✓ Versatility of Operation
- ✓ Fully Shielded Circuit
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STAINLESS STEEL PLATES
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From these large stock plates we produce pattern cut shapes and diameters in any size to your requirements—or deliver the entire plate if desired. Larger plates and patterns can be rolled to your order.

More and more, users of stainless steels come to G. O. Carlson, Inc. for quality and exceptional service. It will pay you to send us your inquiries for plates, patterns and shapes.

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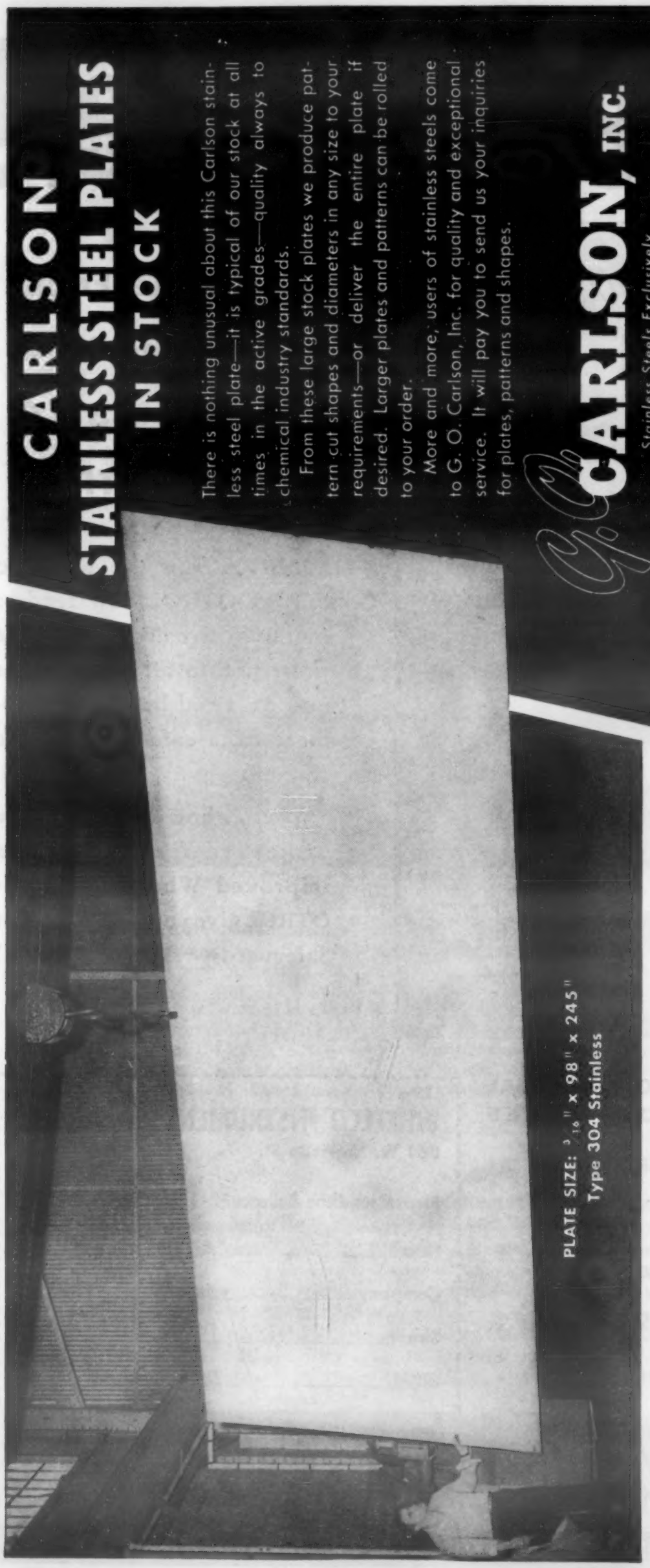
Stainless Steels Exclusively
200 Marshalton Road, Thorndale, Pa.
PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)
District Sales Offices and Warehouse Distributors in Principal Cities

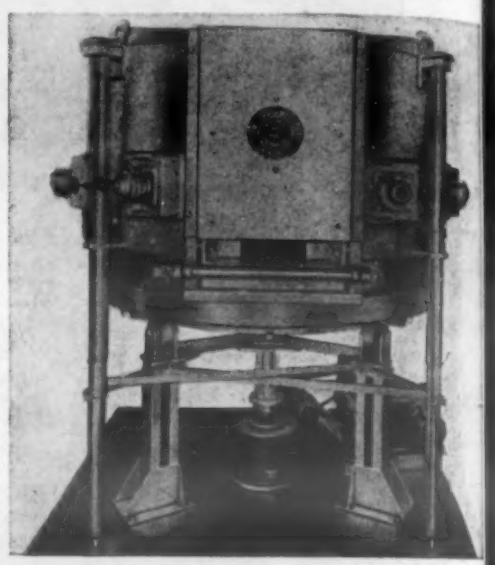


The CARLSON WEEKLY STOCK LIST keeps you posted on what plates are available for immediate shipment. We'll gladly put your name on the list.

New Materials and Equipment

36 min., but can be easily changed to a longer or shorter cycle.

The work is charged and discharged through a single slot 9 in. wide and 2½ in.



Close atmosphere control is a feature of this new Rockwell furnace.

high. This slot has a water-cooled sill that prevents the heat from creeping back along the bar.

The furnace is completely sealed against air infiltration. It can be readily adapted to heat treating of small parts by the addition of a door in place of the slot.

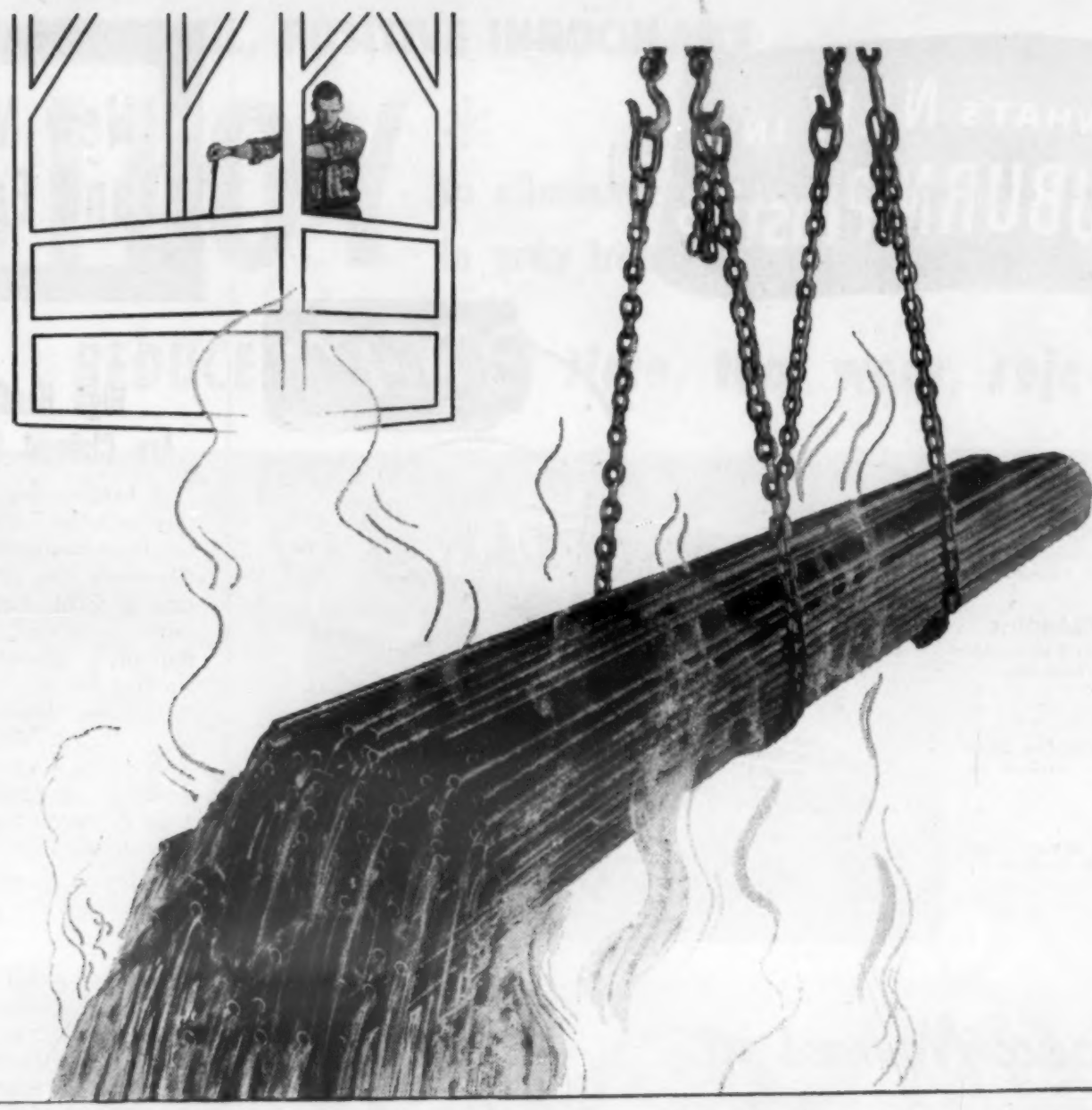
One-man operation, low fuel costs, uniform heating cycle and high output per square foot and floor space are claimed for this equipment.

Equipment Package Designed for Small Soldering, Brazing Jobs

Small soldering, low-temperature brazing, heating or lead-burning jobs can be performed with the No. 75 Air-Acetylene Outfit prepared by *Air Reduction Sales Co.*, 60 E. 42 St., New York 17.

The outfit includes brass torch assembly, four tips, 5 ft. of 3/16-in. flexible hose, a soldering iron, and soldering copper. The four tips are: radiator soldering tip whose slender tubing permits the flame to be used in confined places; No. 9 for medium flames; No. 10 for pointed flames suitable for concentrated heating; and No. 15, which gives a brush-type flame suitable for heating broad areas.

(Continued on page 110)



"We have no fear of any sudden breaks with Monel Pickling Chain on the job!"

You'll always find pickling-room foremen confident of safety with Monel* chain.

Take the chain shown above. It's ¾" Monel, and has been in pickling service over 6 years. In the same plant is another chain, a 1¼" cast acid-resisting chain. Yet, for the heaviest loads, they use the lighter Monel chain because "*. . . we find it reliable and not subject to sudden breaks, as is the case with the cast acid-resisting chain.*"

For over 40 years, Monel has paid its way in pickling service, because Monel resists corrosion by hot pickling acids and fumes. It's stronger and tougher than structural steel. And, Monel welds retain full strength, full corrosion resistance.

So, whether you use chain as slings or in mechanical picklers . . . for longer life and greater safety that chain should be *Monel!*

*Reg. U. S. Pat. Off.

"PICK" MONEL *for all types of pickling equipment. In addition to chain, you can have crates, baskets, tie-rods, hairpin hooks and other pieces fabricated to your design out of economical standard mill forms. For more information on Monel and Monel fabricators, write to our Ray Reddell.*

DESIGNERS and MANUFACTURERS! Sand castings and precision castings of Monel, Nickel, Inconel* and other Nickel alloys are available from INCO's own foundry.

EMBLEM OF SERVICE
INCO
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York 5, N. Y.

"MONEL*" Pickling Equipment means *Extra CAPACITY . . . Extra LIFE . . . Extra SAFETY*

WHAT'S NEW IN AUBURN Plastics

RECORDAK
Red design, clear plastic backed by silver

WESTINGHOUSE
Gold and white design, clear maroon plastic

I-T-E
Silver design, clear plastic backed by black

IBM
Black design, clear plastic backed by gray

Good Names in *Good Nameplates...*

ATTRACTIVE... The design with three-dimensional effect—in any colors—is embedded in lustrous clear plastic. "Crystal Seal" process nameplates are solid shapes of transparent acrylic plastic (Lucite or Plexiglas) with recessed molding in the reverse side. Colors sprayed on the reverse side, using a masking process, bring out the design. Additional color on the back accentuates the contrast and reflects light—or, if there is to be a backlight, the rest of the plate may be left clear.

INEXPENSIVE... Special equipment set up at Auburn, Eastern licensee for the "Crystal Seal" process, permits economical production. Because the colors are inside—bound to the basic plastic form—there is no deterioration from fumes, dirt, or wear. "Crystal Seal" pieces last practically forever. The process is ideal for nameplates, plaques, dials, trim, containers, knobs, insignia, point of sale displays, and a host of other applications where you want permanent good looks at low cost.

Through 73 years of experience Auburn has developed "know-how" that's at your service in the solution of problems involving plastics and their *molding by any method.* Write Auburn Button Works, 410 McMaster St., Auburn, N. Y.

...Engineered Plastics

COMPRESSION, TRANSFER, AND INJECTION MOLDING, AUTOMATIC ROTARY MOLDING FOR MASS PRODUCTION, EXTRUDED ELASTOMERICS, REINFORCED PLASTICS (Fiberglas), MOLD ENGINEERING AND COMPLETE MOLD SHOP

MOLD MARK

Auburn Button Works, Inc.

MOLDERS SINCE 1876 • AUBURN, NEW YORK

New Materials and Equipment

High Hardness, Durability Are Claimed for Casting Plastic

A hard casting plastic, Calcerite-A, employing substantially amino-resins as binders has been announced by *Furane Plastics & Chemicals Co.*, 719 W. Broadway, Glendale 4, Calif. Compared to standard Calcerite, it is said to offer improved water resistance, greater strength, and longer working life.

The new product has a Barco hardness of 65 to 70. When reinforced with glass flock fillers, it can withstand relatively high working temperatures. Calcerite-A cures fully at room temperature and has high dimensional stability.

● A cast nickel alloy, free of copper or iron, and having a tensile strength of 50,000 to 60,000 psi., has been announced by *Waukesha Foundry Co.*, Waukesha, Wis. Known as "Waukesha Metal" Alloy No. 23, the patented composition has an elongation of 7 to 10% and Brinell hardness of 145 to 165 (3000 kg. load). Special properties are high corrosion resistance, good machinability and good anti-seizure characteristics.

Leaded Open Hearth Screw Steel Has Improved Machinability

A leaded, free-machining steel known as Ledloy is again being marketed by *Joseph T. Ryerson & Son, Inc.*, Box 8000-A, Chicago 80. Although a machinability rating for Ledloy has not been established, the new steel is claimed to machine from 30 to 50% faster than AISI B1113 which, until recently, has been accepted as the fastest cutting screw steel.

Composition of the alloy has not been made known, but it is undoubtedly similar to the "E" steel and La-Led compositions announced in the last few months by Jones & Laughlin Steel Corp. and LaSalle Steel Co., respectively. Production of leaded steels was curtailed during the war and in the post-war period, and only recently has manufacture been resumed.

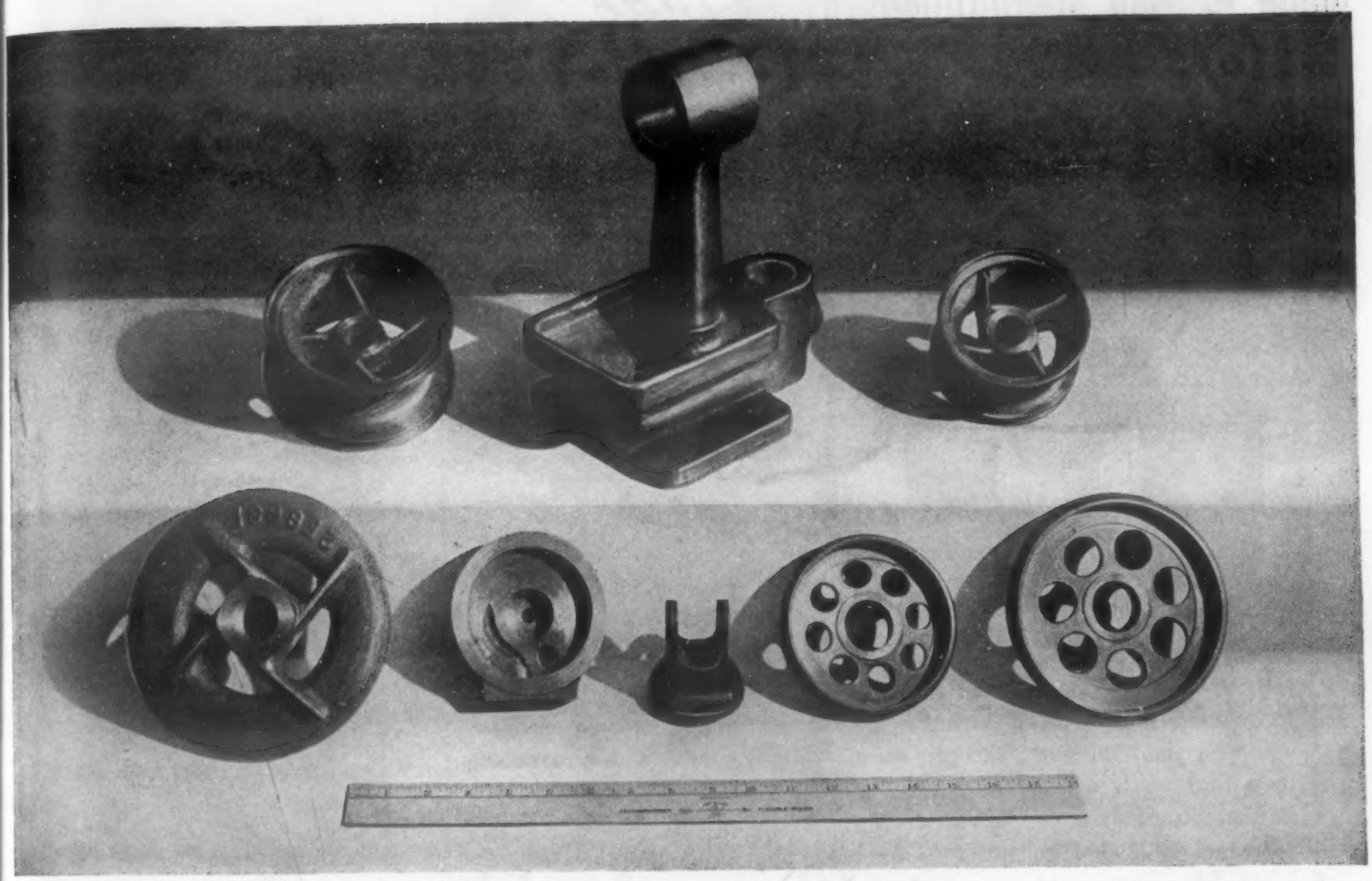
Cutting tools used on Ledloy are said to last from 50 to 200% longer between grinding. Ledloy is also claimed to provide a smoother finish and better base for plating than other free-cutting screw steels. Because it is an open hearth steel, it has good strength and ductility and will carburize better and have a sounder cross section than free-machining Bessemer steels.

SPECIFY THIS POWERFUL, POSITIVE INNOCULANT

NISILOY*

to eliminate hard chilled areas in gray iron castings

. . . REDUCE machining time, tool wear, rejections



Produce *machinable* gray iron castings regardless of sharp variations in section thickness . . .

Eliminate localized hard areas or chilled (white) edges and surfaces . . .

Reduce machining time, tool wear and rejections . . . *raise both quality and quantity of your output by controlling gray iron structure with small ladle additions of NISILOY.*

Designed specifically to promote better machinability, NISILOY is a powerful innoculant and graphitizer containing about 60% Nickel, 30% silicon, balance essentially iron.

*Trade Mark of The International Nickel Company, Inc.

Mail the coupon now . . . for your *free* copy of a booklet that describes how Nisiloy helps you improve structure and machinability of gray iron castings.

EMBLEM OF INCO SERVICE
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
Dept. M. M., 67 Wall Street, New York 5, N. Y.

Please send me your booklet entitled,
"NISILOY" for GRAY IRON CASTINGS.

Name.....*Title*.....

Company.....

Address.....

City.....*State*.....

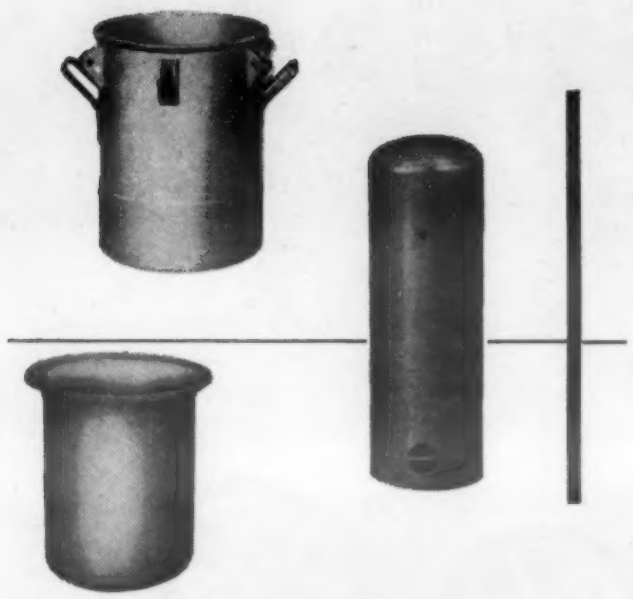
THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET
NEW YORK 5, N. Y.

Prest-O-Lite
Trade-Mark

Cold-Drawn SHAPES and SHELLS

made to your specifications by *Linde*



Leaders of the Field for Over 35 Years

PREST-O-LITE cold-drawn shapes and shells can be quickly and economically produced to your most rigid specifications—from 1½ to 23 inches in diameter and up to 50 inches in depth. Our greatly expanded, well-equipped plant has every modern manufacturing facility and is manned by a thoroughly experienced, highly specialized staff—prime requisites of a quality product.

LINDE engineers will gladly help you solve your production and design problems involving cold-drawn shells, cups, containers, receivers, pressure vessels, formed parts, or other shapes.

The term "Prest-O-Lite" is a trade-mark of The Linde Air Products Company.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Principal Cities

In Canada: DOMINION OXYGEN COMPANY, Limited, Toronto

The Linde Air Products Company
30 East 42nd Street
New York 17, N. Y.

Please send literature and full information about cold-drawn shapes and shells.

NAME _____

COMPANY _____

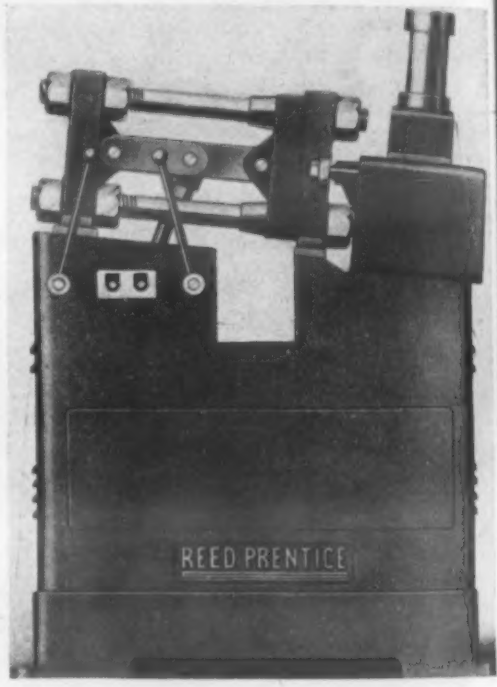
ADDRESS _____

New Materials and Equipment

Lead, Tin or Zinc Alloys Die Cast by Small Self-Contained Machine

High-speed production of die castings of lead-, tin- or zinc-base alloys is made possible by a small, self-contained machine manufactured by *Reed-Prentice Corp.*, Dept. D-1, Worcester 4, Mass.

Designated Model No. 0, the new die casting unit has a maximum shot capacity of 1 lb. of zinc, and will produce up to



This Reed-Prentice die casting machine will produce up to 600 shots per hr.

600 shots per hr. The capacity and speed of this machine make it ideal for rapid, continuous production of small pieces such as knobs, handles, gears and fittings.

Die plates measuring 10 by 10 in. provide a maximum casting area of 9 sq. in. at 1300 psi. The holding pot into which the molten metal is ladled has a capacity of 75 lb. of zinc. Machine dimensions are 33 by 12 by 44¾ in.

The machine is manually operated by hydraulic pilot valve control levers. Plunger control is interlocked to prevent making the shot unless the dies are closed.

● *Kester Solder Co.*, 4201 Wrightwood Ave., Chicago 39, is now supplying solder preformed in rings, pellets, washers, and unusual shapes and sizes to specifications. Solder preforms are used to assure uniform results where continuous or repetitive soldering is required.

Tru-Spot Flashlight—*made from Kaiser Aluminum* by Ekco Products Company, 1949 North Cicero Ave., Chicago, 39. The one-piece seamless case is 6⅜ inches long, 1½ inches in diameter, with a flared top 2 inches in diameter.

Drawn from a blank...with no annealing!

In eight easy stages the Tru-Spot Flashlight case is drawn from a blank of Kaiser Aluminum—*automatically*—without a single anneal!

Consistent high quality and workability of Kaiser Aluminum make this operation successful and economical—and give Ekco profitable advantages like these:

Lower manufacturing costs—due to elimination of many steps in handling and fabricating. Low cost tooling set-up—because Ekco uses exactly the same equipment formerly used for a more expensive metal!

Scrap loss is cut. Plating is unnecessary because a bright, lasting finish is produced merely by buffing!

And the sturdy seamless case has unmatched sales appeal!

No matter what fabricating method *you* use, chances are you can profit with Kaiser Aluminum—the *versatile* metal that combines strength, durability, lightness, workability. Call any Permanente Products' sales office for more information.

Permanente Metals

PRODUCER OF

Kaiser Aluminum

SOLD BY PERMANENTE PRODUCTS COMPANY, KAISER BUILDING, OAKLAND 12, CALIFORNIA . . . OFFICES IN: Atlanta • Boston • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Houston • Indianapolis • Kansas City • Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Portland, Ore. • Rochester, N.Y. • Seattle • Spokane • St. Louis • Wichita
EXPORT OFFICE, OAKLAND, CALIFORNIA • WAREHOUSE DISTRIBUTORS IN PRINCIPAL CITIES

ANOTHER 3M COMPANY NEWS STORY

A helping hand to Hires new dispensers

Pleasing and welcome sight . . . those clean, sparkling Hires dispensers. And 3M Adhesives help make and keep them so despite low operating temperatures, inevitable spillage and hard use.

CORK INSULATION keeps them cool—and a 3M Adhesive does a double-barreled job. It seals the cork against moisture penetration and consequent loss of insulating efficiency. It also eliminates slow-to-assemble, heat transferring mechanical fasteners. The "adhesive method" speeds production AND makes a better unit.

ANOTHER 3M ADHESIVE bonds a rubber gasket to the metal case. Unaffected by cold or moisture, this adhesive always remains resilient to absorb the gasket's flexing—to keep the gasket from popping off.

These are just two of the more than a 1000 adhesives, coatings and sealers the 3M Company compounds... specific products for critical jobs. If you have an adhesive or sealing problem, ask for our free consultation service. Just write the Adhesives and Coatings Division, Dept. M119, Detroit.

3M BRAND ® ADHESIVES

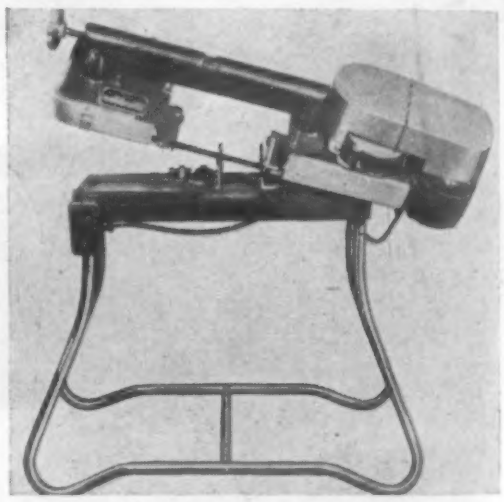
MINNESOTA MINING & MFG. CO.
Also makers of "Scotch" Brand Pressure-sensitive Tapes, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Abrasives.
General Offices: St. Paul 6, Minnesota
Adhesives and Coatings Division, Detroit 2, Michigan
General Export: Durex Abrasives Corp., New Rochelle, N. Y.
In Canada: Canadian Durex Abrasives Ltd., Brantford, Ontario

New Materials and Equipment

Horizontal Metal-Cutting Band Saw Built Especially for Small Shops

Wells Manufacturing Corp., 380 Service Rd., Three Rivers, Mich., has announced production of a small horizontal metal-cutting band saw. The saw has a capacity of 3½ in. for rounds and 3½ by 6⅜ in. for rectangular shapes. Known as Model 49A, it is designed especially for small shops and for general utility work in larger shops.

Bed area of 49A is 6½ by 24 in. Height to top of bed is 24 in. Floor space requirement is 16½ by 38 in., and net weight is about 118 lb.



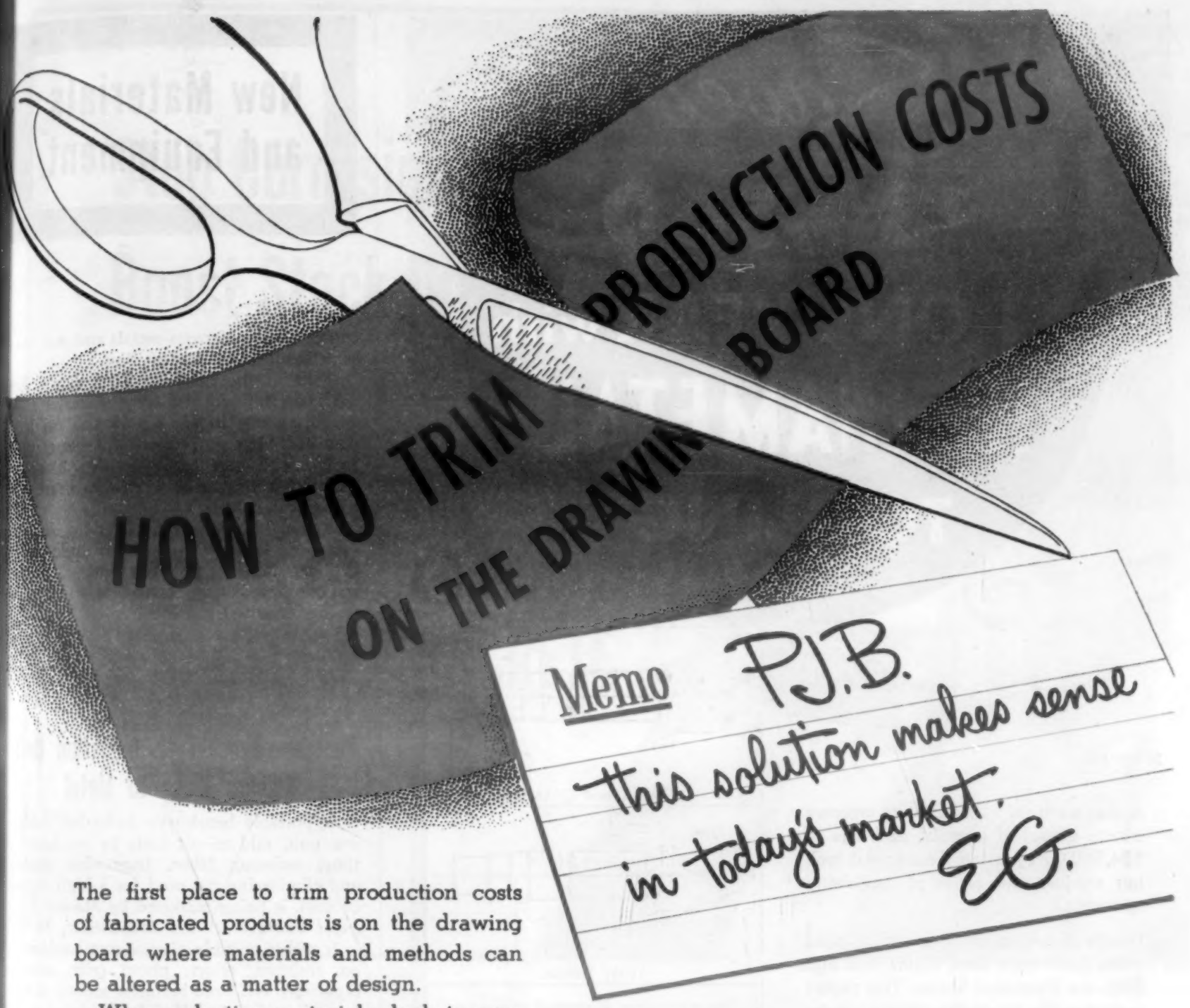
This Wells band saw cuts 3½-in. rounds and 3½ by 6⅜-in. rectangular shapes.

The blade (½ in. by 0.025 in. by 5 ft.) is driven by a 1/6-h.p. ball bearing motor with manual start and automatic stop. A V-Belt drive provides selective speeds of 54, 100 and 190 ft. per min. The saw is also equipped with a quick-action vise and adjustable blade guides.

Improved Cemented Carbide Grade Makes Possible Longer Tool Life

Recent improvements on Grade 905 of Carboloy cemented carbide are said to provide higher hardness, more wear resistance, greater cutting edge strength and cratering resistance, and more rapid dissipation of heat at the cutting edge. Manufactured by *Carboloy Co., Inc.*, Detroit 32, Mich., Grade 905 is used for finishing and light roughen-

(Continued on page 120)



The first place to trim production costs of fabricated products is on the drawing board where materials and methods can be altered as a matter of design.

When selecting materials, look to genuine Hussey Copper to give fabricating economies that keep production costs low. Hussey Copper will stamp, form, turn or spin to any shape with the lightest of equipment. It will solder, braze, crimp, rivet, bolt, screw; or laminate to other materials.

Hussey Copper offers utmost versatility, too. With it you can obtain electrical or thermal conductivity, corrosion resistance, lifetime durability, lasting beauty and decoration, and acknowledged top quality.

To trim production costs, design with Hussey Copper. Use its most advantageous form—sheet, coils, rod, wire or tubing. There's a supply near your manufacturer in any of Hussey's seven complete warehouses.

C. G. HUSSEY & COMPANY
(Division of Copper Range Co.)
ROLLING MILLS AND GENERAL OFFICES
PITTSBURGH, PA.

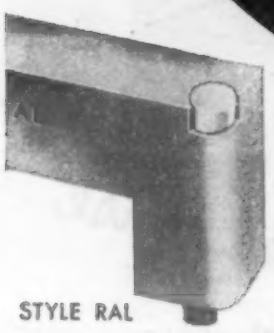
Hussey Warehouses carry stocks of Copper and Brass Products for Prompt Shipment

7 convenient warehouses to serve you promptly!
PITTSBURGH, 2850 Second Avenue • CLEVLAND, 5318 St. Clair Avenue • NEW YORK, 140 Sixth Avenue • CHICAGO, 3900 N. Elston Avenue • ST. LOUIS, 1620 Delmar Boulevard • PHILADELPHIA, 1632 Fairmount Avenue • CINCINNATI, 424 Commercial Square

HUSSEY

OUR 101st YEAR!

Saves $34,560 IN ONE YEAR with KENNAMETAL TOOLING

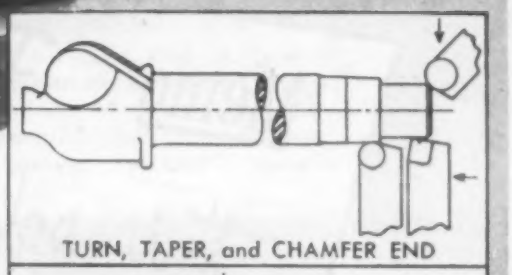


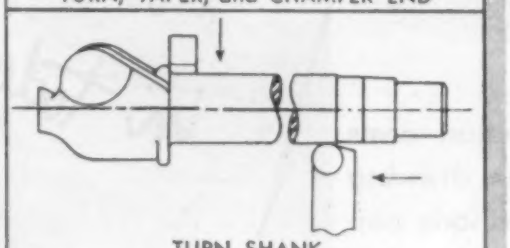
A manufacturer of automotive steering gears effected annual savings of $34,560.00 by using Kennametal tooling on just one series of machining operations.

Details of the job are given at the right —the basic tools used, Styles RAL and SBR, are illustrated above. This report indicates the enormous savings attainable through the application of modern tooling.

Here again Kennametal proves its worth. A few pennies saved in the initial cost means nothing. Consider these facts: (1) Fewer tools are required, as a rule; (2) Set-up and machine downtime are minimized; (3) Load and confusion in grinding room is reduced; (4) Higher production rates can be reached, and maintained.

Ask us to send you performance reports that show how other shops are achieving cost reduction by tooling with Kennametal.





The operations illustrated above required ten single-point brazed tools. Four Kennamatic tools are now being used. The savings on each 1000 pieces machined is $24.00, as detailed below. A total savings of $34,560.00 was realized over a 12-month period.

TOOL PERFORMANCE

	Single-Point	Kennamatic
Number Required	10	4
Cost Each (Avg.)	$2.50	$4.10
Pieces/Grind	200	1,600
Pieces/Tool Life	2,000	24,000

SHOP COST/1000 PIECES

	Single-Point	Kennamatic
Tool Cost	$15.00	$ 1.93
Productive Labor	15.12	9.32
Non-Productive Labor	6.00	0.87
Shop Cost/1000 pcs.	$36.12	$12.12

ROUGH FORGING

FINISHED

KENNAMETAL Inc.
LATROBE, PA.
MANUFACTURERS OF SUPERIOR CEMENTED CARBIDES AND CUTTING TOOLS THAT INCREASE PRODUCTIVITY

New Materials and Equipment

ing cuts on nonferrous metals and cast irons with hardness up to 550 Bhn.

Tests by the company have shown that tools tipped with the new material have longer service life and hold size on long cuts and high production jobs better than tools tipped with the former 905. The new material is said to be as easy to braze and grind as the old 905.

Among the varied applications of this cemented carbide product are automotive cylinder boring, piston grooving, tractor track roller boring, clutch pressure plate facing, camshaft bearing turning, etc.

Portable Bench-Type Induction Unit Solders Glass to Metal

A portable bench-type induction soldering unit, said to cut costs by minimizing time, reducing labor, improving quality and eliminating the need for a high degree of skill, is being marketed by *Marion Electrical Instrument Co.*, Manchester, N. H.

It makes possible glass-to-metal soldering on resistors, relays, photo cells, meters, capacitors, etc. True hermetic sealing is also possible with this device. It is claimed to be ideal for terminal, magnet and bearing assembly.

The unit draws 775 watts at full power and 100 watts at standby; it operates on 115-v., 60-cycle current. The instrument weighs 150 lb. and measures 15¾ by 21½ by 15 in.

High-Hardness Tool Bits, Blades Contain Approximately 13% Cobalt

A new series of cutting tools, having hardness of 66 to 68 Rockwell C and tensile strength better than 300,000 psi., has been announced by *Plew Tool & Metal Heat Treat*, Columbia City, Ind. Favorable hardness and toughness properties of the "Lucky 13" series are attributed to the cobalt content of about 13%, and a series of high and low temperature heat treatments.

Standard ground square tool bits come in sizes 3/16-in. square by 2-in. length up to 1 by 7 in. Standard ground flat tool bits range from ¼ by ⅜ by 3 in. to 1 by 1¼ by 6 in. Ground cut-off blades are available from 3/32 by ½ by 5 in. to 5/16 by 1 by 6½ in. Special sizes are made to order.

Stop Corrosion... Boost Stack Drafts, Save Time, Cut Costs with LUMNITE* REFRACTORY CONCRETE LININGS

Your steel stacks are fully protected against heat and corrosion when Lumnite Refractory Concrete linings are installed. When made with Lumnite and insulating aggregate, these linings boost drafts by keeping gas temperatures up. They resist attacks of condensate and sulphurous gases. Linings are jointless, allow no "breathing." Lumnite concrete thus adds years of service to old stacks, protects new stacks indefinitely.

Lumnite Refractory Concrete linings are easily installed. They are trowelled in place or "shot" by concrete gun over reinforcing mesh. Outage time for repairs is kept to a minimum because Lumnite linings reach service strength in 24 hours or less. Thus long service and easy maintenance give you time- and money-saving operation. For further information on Lumnite Refractory Concrete in stack linings, flues and other uses, write to Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

SPECIFY CASTABLES MADE WITH LUMNITE

Where suitable aggregates are not readily obtainable, tailor-made mixtures, ready for immediate use, are available. These factory-prepared mixtures of Lumnite and selected aggregates, when mixed with water on the job, may be cast into place for furnace door linings, arches, blast furnace pads, annealing furnace car tops and door linings. Special shapes can be cast in molds—ready within 24 hours. Castables made to meet specific temperature and insulation requirements are prepared by manufacturers of refractories and sold by their distributors.

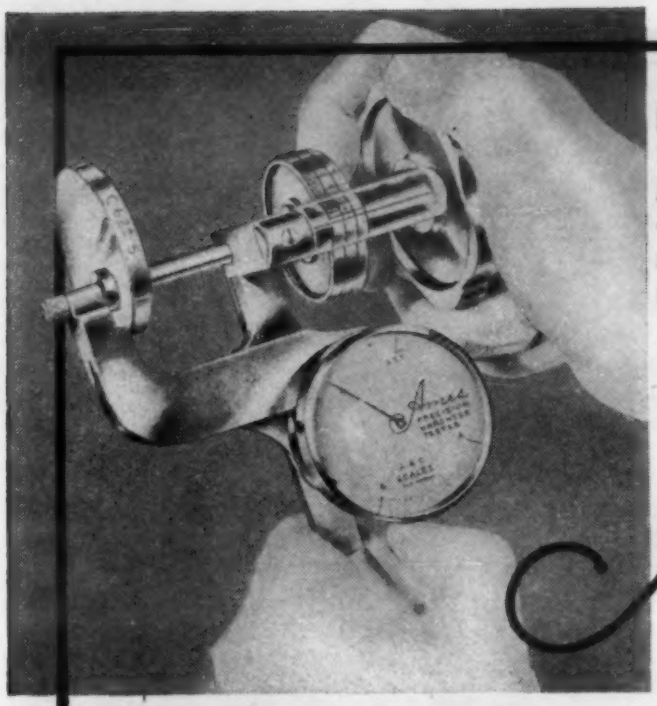
**"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

MM-L-21

A UNIVERSAL ATLAS PRODUCT

LUMNITE® FOR REFRACTORY CONCRETE

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*



For accurate, on-the-spot hardness tests on production line, in stock room, warehouse or in the shop. Used by inspectors, field men, engineers, salesmen.

Ames

PORTABLE

HARDNESS TESTERS

Amazing savings in time and expense can be realized by taking the Ames Hardness Tester to the work. For hardness testing flat or round stock, tubing, duplicate parts, knives, saws and irregular shaped pieces, reading directly in the Rockwell Scales. No cutting off specimens. No laboratory delays. Complete with wooden carrying case. Several sizes. Write for bulletin.

AMES PRECISION MACHINE WORKS

Makers of Precision Bench Lathes & Milling Machines

WALTHAM 54, MASSACHUSETTS

ALLMETAL'S First Quality

STAINLESS STEEL FASTENERS

IMMEDIATE DELIVERY • ALL TYPES & SIZES

help make your products fully non-corrosive.....

For first-quality stainless fastenings see Allmetal first! All types and sizes of machine, set, self-tapping, wood screws, nuts, bolts, pins, washers, rivets, available for IMMEDIATE DELIVERY from America's most complete stock. Specials to order.

WRITE, ON YOUR LETTERHEAD, FOR CATALOG No. E49

STAINLESS STEEL FASTENERS

MANUFACTURERS SINCE 1929

ALLMETAL

Screw Products Co., Inc.

33 GREENE STREET, NEW YORK 13, N. Y.

New Materials and Equipment

Plastics Granulating Machines Adapted to Serve Molding Units

Remodeling of two sizes of plastics granulating machines to adapt them for installation in connection with injection molding machines has been announced by *Cumberland Engineering Co., Inc.*, Providence, R. I.

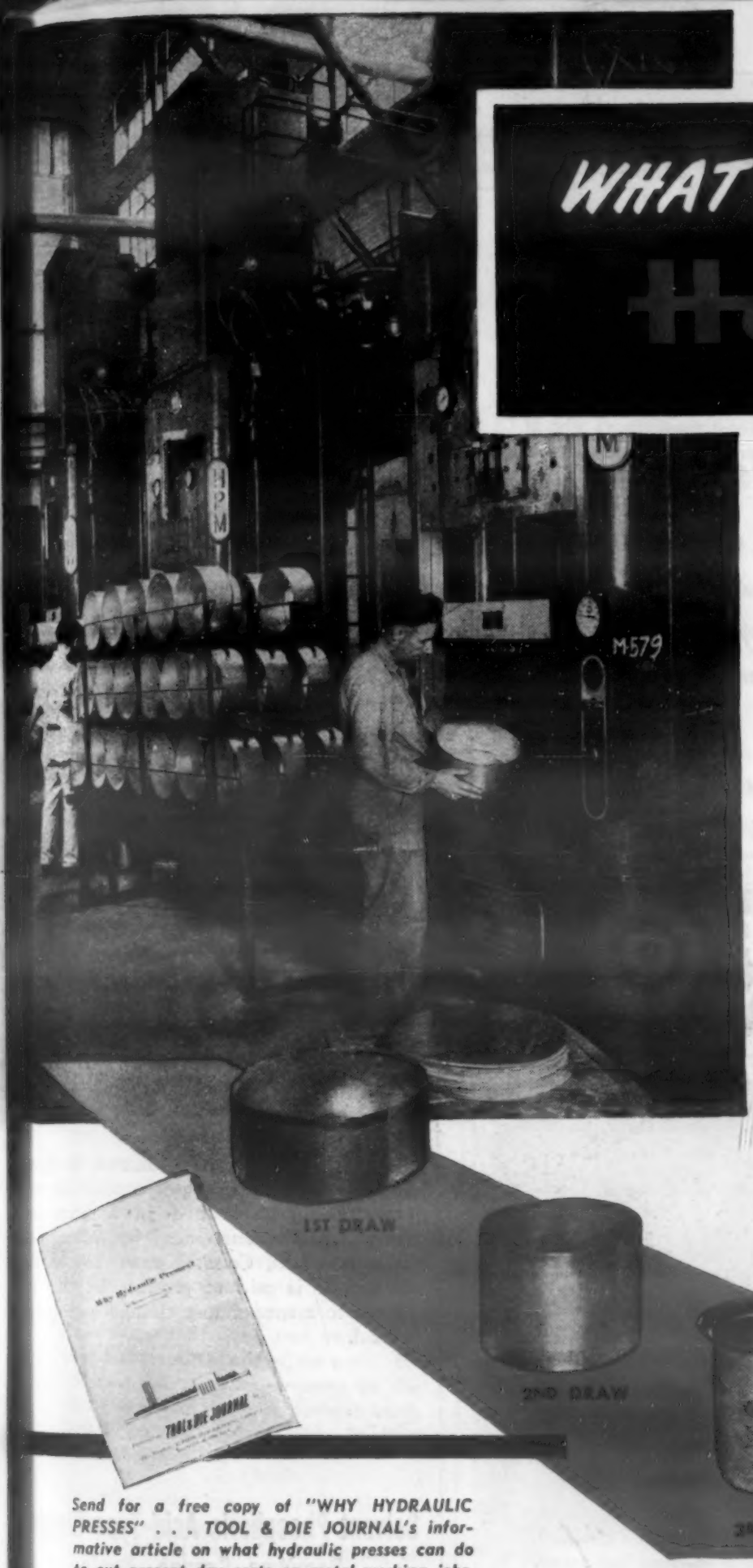
The new machines, Nos. 0 and ½, feature a smaller motor in the base, V-belt drive and built-in, dust-tight material container.

Such installations are being adopted by

Pictured here is the remodeled Cumberland No. 0 plastics granulating machine.

many operators because it permits them to trim parts and feed the sprues and runners directly into the granulating machines. This practice saves labor and handling of material to and from central grinding stations, and the possibility of mixing colors is avoided.

● An electrode holder which remains cool while operating up to 725 amp. on ⅜-in. electrodes has been announced by *Martin Wells, Inc.*, 5886 Compton Ave., Los Angeles 1.



WHAT'S COOKIN' AT Hotpoint?

H-P-M HYDRO-DRAWING AND BULGING SOLVES A TOUGH *Production Job*

Look at the complex shape of this aluminum deep well cooker shell for Hotpoint electric ranges! Yes, it's a real "toughie", but H-P-M double-action hydraulics make quick work of it . . . a draw every 10 seconds . . . 165 bulges per hour!

Take a tip from Hotpoint . . . choose modern H-P-M hydraulics for your sheet metal forming jobs. You'll get deeper draws, fewer rejects, longer die life, quicker die set-up and a fast cycle. H-P-M hydro-bulging can't be beat for complicated necked shapes.

Call in a nearby H-P-M engineer. Find out what money-saving H-P-Ms will do for you. There's no obligation . . . write today.

THE HYDRAULIC PRESS MFG. COMPANY
1054 Marion Road • Mount Gilead, Ohio, U.S.A.

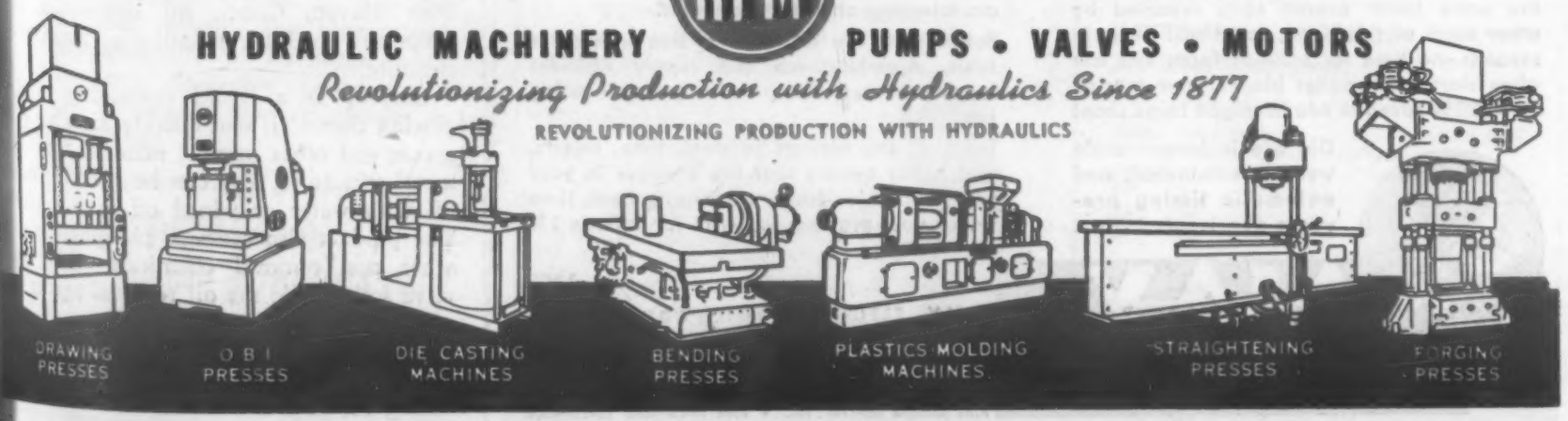
Send for a free copy of "WHY HYDRAULIC PRESSES" . . . TOOL & DIE JOURNAL's informative article on what hydraulic presses can do to cut present day costs on metal working jobs.

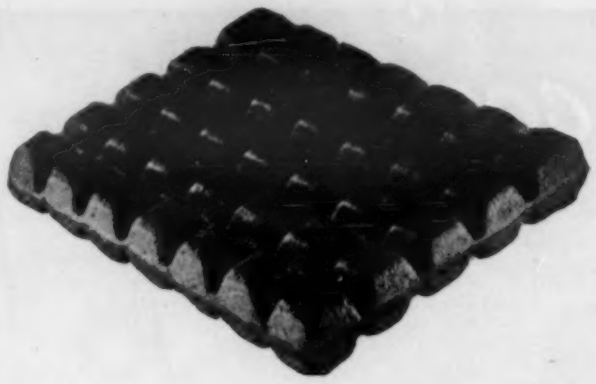
HPM

HYDRAULIC MACHINERY **PUMPS • VALVES • MOTORS**

Revolutionizing Production with Hydraulics Since 1877

REVOLUTIONIZING PRODUCTION WITH HYDRAULICS





A Little Does a Lot

GCC CERIUM METAL (Mischmetal) added in small quantities to many Ferrous and Non-Ferrous Metals improves the metallurgical and mechanical properties of the end products.

Discover how a little does a lot by writing for our informative bulletins.

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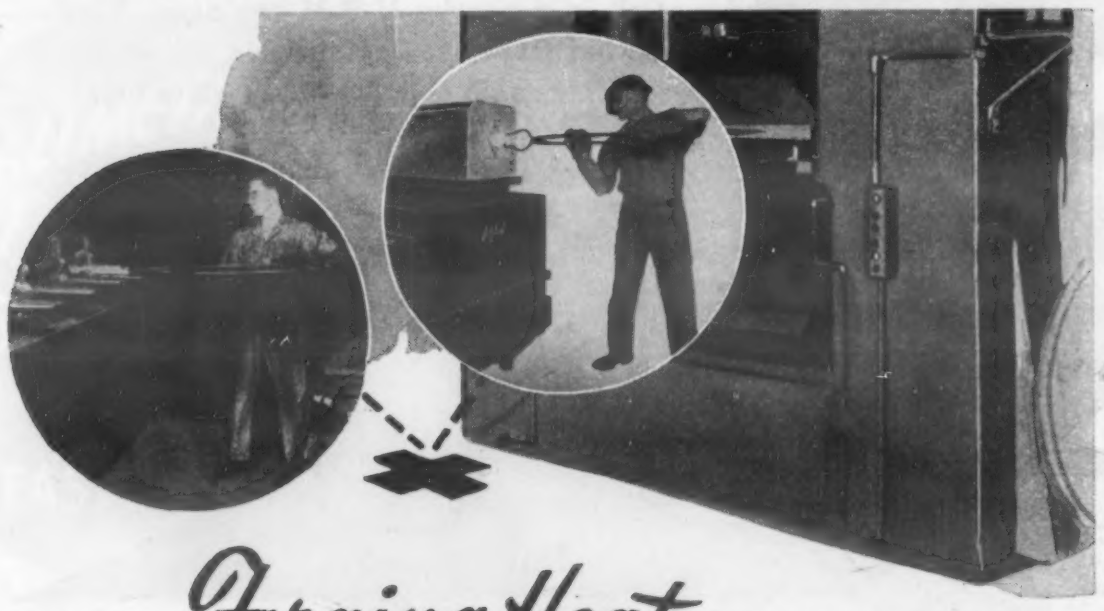

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New Materials and Equipment

New Fibreglas-Silicone Rubber Gaske Can Be Used up to 500 F

A heat-resisting gasketing material co sisting of woven Fibreglas cloth coated wi silicone rubber has been developed b *Acushnet Process Co.*, New Bedford, Ma It is recommended for use up to 500 F.

In addition to heat resistance, advantag claimed for this material are: light weigh minimum thickness, and good strength an oil resistance. At the present time it i being used primarily as a gasket betwee the rocker box and rocker box cover i aircraft engines.

The material is now being furnished i only one thickness, that varying betwe 0.013 and 0.020 in. The Fibreglas clot itself weighs 6 oz. per sq. yd., and ha minimum breaking strength of 250 lb. pe in. on the warp and 200 on the fill.

● A new radiation pyrometer, designe for indicating, recording or controlling tem peratures up to 4000 F in furnaces an kilns, has been announced by *Bristol Co* Waterbury 20, Conn. Known as the Py rovisor, it is said to produce a 99% re sponse to a temperature change within on second.

Solvent Phosphoric Acid-Type Cleane Removes Grease, Scale

A new solvent phosphoric acid-typ cleaner, Surprep, has been developed b *Enthone, Inc.*, Dept. MA, 442 Elm St New Haven, Conn., for degreasing an preparing steel for painting at room tem perature.

Surprep is a liquid containing oil-dis placing chemicals that quickly dislodge oil grease and other organic material from th metal surface so they can be quickly rinse off with water or wiped off with a cloth The product also contains phosphating an other rust removal chemicals which dis solve scale while the oil removal agents ar operating.

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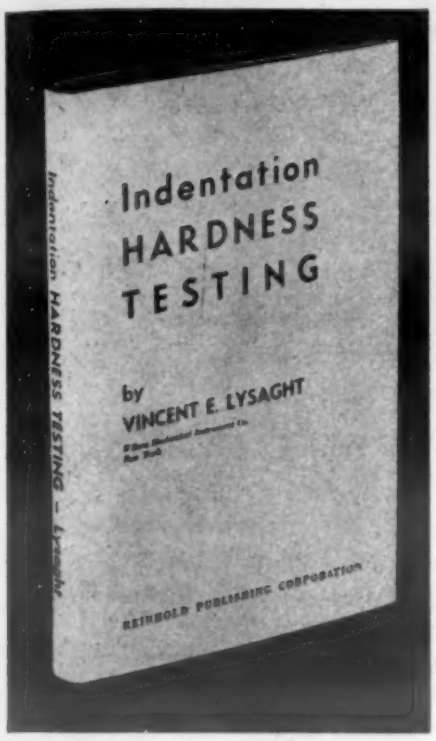

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Useful, factual and based on up-to-date industrial research practice, this new book covers the many problems involved in the hardness testing of metals and other materials. It describes the instruments in most common use—the Brinell, Rockwell, Scleroscope and Diamond Pyramid, as well as those used for specialized types of hardness tests. The author evaluates the advantages and disadvantages of each test and gives complete specifications for each. He covers the recent advances in the field and the work of present hardness committees of the leading technical societies.

Whether you are a metallurgist, a testing engineer, a machine operator or a student, you will find much of value in this complete story of hardness testing. The more advanced student and research investigator will find sufficient theory to afford a comprehensive basis for practical hardness testing. The plan, scope and simplicity of language make the book admirably suited for a text in schools offering courses in metallurgy.

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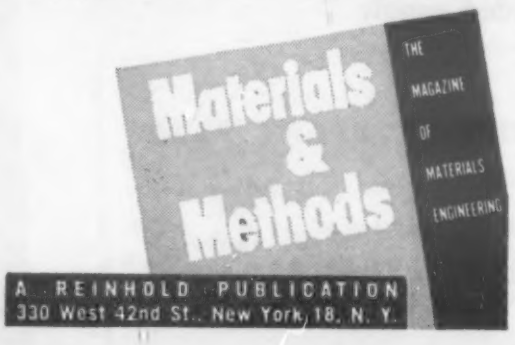

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EDITORIAL

A New Approach to Economics

For as many years as mass production has been a reality, one of the basic principles has been the use of the least expensive materials wherever possible. That concept still holds, but many engineers are following a new interpretation of the old rule.

Not so long ago there were only a few materials from which a choice could be made. There were iron, steel, bronze, brass, copper, lead, wood and, perhaps, a few other materials from which a choice could be made. As time passed, and our civilization and its requirements became more complex, variations were developed in each of these material groups and entirely new ones were produced, including such items as plastics and synthetic rubbers.

Generally, a new material or variation of an old one was developed to fulfill the requirements of one specific application. However, most of these materials could well be adopted for other products with benefit to both manufacturer and ultimate consumer. The taking of such steps is generally slow, or at least has been slow in the past, for in most cases the newer materials were more costly than the old. The cost factor showed their acceptance.

The new interpretation of an old concept of which we speak has to do with understanding that in many cases even though the newer materials are more costly, from a purchasing agent's point of view, they really can be much cheaper in the long run.

This is not meant to imply that a material or metal form should be discarded simply because it is old or because newer materials have been developed in its general field. We do suggest that periodically all materials used be reexamined to see if they are really doing the job they should do. One good source of help in making such evaluations is the file of reports made by service engineers. These will show the points of weakness in any product.

Your customers have a right to expect a definite, trouble-free life of any product they buy. The use of any but the best of materials for your specific application is not playing fair with the people on whom you depend for your personal and business existence. For example, you make valves for a specific industry. Valves are expected to last a long time without the need for frequent maintenance or replacement. Should your valve be designed to use an inferior material in any of its parts, its chances for long life are remote. A failure in service is costly to your customer. It is costly to you to make replacements. You will probably lose that customer.

Probably most products now in general use could be made of any one of several materials and by any one of several fabricating methods—but there is only one best combination. It is up to you to find that best combination for your product. And don't discard that best combination merely because it happens to cost more. The added cost may save itself many times over when your product finally goes into the hands of your customers.

T. C. Du Mond
Editor

Materials & Methods®

THE MAGAZINE OF MATERIALS ENGINEERING

VOLUME 30, NUMBER 6 • DECEMBER 1949

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News Digest

ASME Examines Future of Metals and Ceramics in Gas Turbines

Although there must be a continuing effort to discover new materials for high temperature service, improvements in the treatment of materials and in the design of parts would enable us to use existing materials to much better advantage. This theme was easily discerned in two papers presented before the national convention of the American Society for Mechanical Engineers in New York recently.

Subject of these papers was heat resistant materials for gas turbines—their present stage of development and future outlook. "Metals for Gas Turbines" were covered by Norman L. Mochel, Manager of Metallurgical Engineering and Consulting Engineer, Westinghouse Electric Corp. Two Battelle Memorial Institute assistant supervisers, W. H. Duckworth and I. E. Campbell, discussed "The Outlook for Ceramics in Gas Turbines."

Longer Service Life

Mochel pointed out that metallurgical development of gas turbine applications in other fields than aviation raises several problems that cannot be solved by data based on aviation studies. Among these problems are (1) the effect of long service and the corrosive effect of cheaper fuels over those longer periods of time on rupture and fatigue properties, and (2) the extent to which properties developed in small pieces can be realized in the larger pieces that will be needed.

The fact that Inconel and 25:20 chromium-nickel steel have performed better than several "superalloys" as combustion-chamber liners indicates, according to Mochel, that reasonable service life for these liners will be accomplished more through careful design than merely by seeking increasingly resistant materials. Existing materials also appear adequate for turbine casings and ducts; in fact, Mochel finds that difficulties of procurement and manufacture are far more important at this stage than the material itself.

Although experience in high temperature steam turbines has demonstrated the superiority of single-piece rotor forgings, inability to produce large, reliable forgings of heat resisting materials makes it necessary to rely, at least temporarily, on disks assembled by welding or other means.

Precision Cast Blades

Inasmuch as future turbine development may lead to temperatures at which only cast materials can be used, precision casting of blades is of increasing interest. Although present production yields are low and improved metallurgical control is needed, this method eliminates much of the waste incurred in forging and machining. Mochel pointed out that hollow blades would save critical material, could be cooled, and would result in lower stresses on the blade fastening.

For service temperatures up to 1500 F, Mochel believes more is to be gained by examining the effects of heat treating and working on existing alloys than by further alloy variations or additions. Many alloy fields have been explored in an effort to develop materials having worthwhile load-carrying capacity at higher temperatures, *e.g.*, 1600 to 1750 F. Not yet fully explored are the alloys based on titanium, chromium, molybdenum or tungsten, but the advantages to be expected from new alloys appear doubtful.

Ceramics Available

Along with the realization that alloy development has just about reached its limit comes a certain amount of encouragement from the ceramists. Duckworth and Campbell believe close cooperation between ceramists and engineers will produce gas turbines with higher operating temperatures, longer life and possibly lower weight.

According to these authors, most of the refractory oxides and many combinations of oxides have been investigated, though there is room for much more research on combinations of oxides. The development and evaluation of mixtures of titanium carbide and cobalt for rotor blades is well advanced, but only preliminary investigations have been made on the bodies of refractory carbides, nitrides, borides, silicides, etc., singly, in combination with each other, or combined with metals.

A major problem in blade materials is thermal conductivity. In bodies having high thermal conductivities, oxidation and wheel cooling may be encountered, whereas lack of sufficient thermal shock resistance may seriously limit use of low-conductivity bodies. Since thermal shock requirements for actual use cannot now be related to the thermal shock properties of a material, some kind of simulated service test is required for accurate appraisal.

Ceramic Blades

The lower mechanical requirements of stator blades make the use of ceramic bodies for this application more likely than for rotor blades; even without higher operating temperatures such blades, replacing metal blades in present designs, might reduce weight and cost. Although lack of ductility prevents direct substitution of ceramic bodies for sheet metal now used for combustion-chamber liners, it is possible that metal-supported, ceramic liners will withstand service conditions.

Much attention is being devoted to the development of ceramic coatings for metals, with a view toward extending considerably the usefulness of alloys. Enamel-type coatings have increased appreciably the life of rotor blades and combustion-chamber liners. Certain metal-ceramic coatings appear to be more heat resistant than the enamel-type coatings.

Extrusion Process for Steel

A new extrusion process for steel which is expected to save up to 30% or more in steel fabricating costs was announced recently. It has been developed and patented by René Perrin, metallurgist and executive of Comptoir Industriel d'Etirage et Profilage de Métaux, a subsidiary of Société d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electrique d'Ugine.

The French process is said to make possible the extrusion of extremely intricate forms and sections, thus eliminating many costly forging and machining operations. The production of finished alloy gears in two operations is one accomplishment claimed for the new forming method.

Further details on the Ugine process have not yet been released.

Electroplating Research Produces New Plating Bath for Molybdenum, Improved Anode for Tin Deposition; Technical Sessions Scheduled

Two recent developments in electroplating have been reported in the *Journal of the Electrochemical Society* (October). These developments consist of a new plating bath for the electrodeposition of alloys of molybdenum with cobalt, iron and nickel, and an anode which makes it possible to obtain markedly increased current densities in alkaline tin plating.

Plating Molybdenum Alloys

The aqueous citrate bath for plating molybdenum alloys with cobalt, iron and nickel was developed by H. J. Seim and M. L. Holt, of the University of Wisconsin.

The plating solution contains the sulfate of the codepositing metal, citric acid and sodium molybdate; ammonium hydroxide is used to adjust the pH. A bath temperature of about 77 F is preferred. The highest proportion of molybdenum (about 50% and more) is obtained with iron as the codepositing metal, and the lowest is with nickel.

Generally, the authors of this paper found that highest current efficiencies were obtained with the nickel-molybdenum bath and the lowest with the iron-molybdenum bath; at pH 4, however, the current efficiencies were about the same, and at pH 5, the cobalt-molybdenum bath showed highest efficiency.

Alkaline Tin-Plating

The addition of about 1% aluminum to the tin anodes used in alkaline tin plating considerably increases the current densities obtainable. This conclusion is the result of research by Frederick A. Lowenheim, of Metal and Thermit Corp., in which the effect of 26 elements upon the anode behavior of tin in alkaline solutions was investigated.

Many of these elements were found to have little effect when added in proportions up to about 1%. A few elements, in addition to aluminum, appeared to have some beneficial effects, but all had certain drawbacks. It has also been shown that small amounts of some metals, notably cadmium, indium and nickel, have strong passivating action and should definitely be avoided in tin anodes.

According to the author, aluminum appears most promising from a practical standpoint because it alloys smoothly and easily with tin, forms stable alloys having good mechanical properties, produces no observable deleterious effect on the bath, and is cheap and nonpoisonous.

Society Lists Two Meetings

Activity in the electroplating field became evident recently with announcement of two important meetings scheduled next year and a new research project on plating room waste disposal.

The Fourth International Electrodeposition Conference will be held June 12 to 16, 1950 in Boston in conjunction with the annual convention of the American Electroplaters' Society. Collaborating will be the Electrodepositors' Technical Society of England. Since a symposium on "Advances in Electroforming, Including the Graphic Arts" is planned, the Association of Electrotypers and Stereotypers will be invited to participate in that session.

Earlier, on Jan. 14, the Chicago branch of the American Electroplaters' Society will hold its annual banquet and educational session. Papers to be presented are: "New Directions in Research," by William Blum; "Factors Affecting Throwing Power," by R. O. Hull; and "New Developments in Nickel Plating," by B. B. Knapp.

Disposal of plating room wastes without polluting rivers is a major problem of metal-working industries today. The object of Research Project No. 10, sponsored by the American Electroplaters' Society, is to evaluate known methods for treatment of plating room wastes and to attempt to develop new methods of treatment. It is hoped that the information thus obtained will enable engineers to design equipment for specific installations, keeping costs at a minimum. One preliminary result of this project is a procedure for determining very small amounts of cyanide in plating room waste; the method will be published soon. The project is being carried out at Yale University under the direction of Professor B. F. Dodge.

Light Alloy Rail Cars

Use of an aluminum-magnesium alloy, A-G5 (5 magnesium, 0.5% manganese), throughout the chassis construction of French rail passenger cars has resulted in the production of the lightest cars yet announced (*Metal Industry*, Oct. 14).

The alloy was chosen because of its good mechanical properties, ductility ensuring workability, high corrosion resistance and weldability. By way of contrast, the lightweight Talgo train (MATERIALS & METHODS, Sept., p. 57) built recently by American Car & Foundry Co. contains a wide variety of aluminum alloys and aluminum-plywood sandwich materials.

Approximate range in weight of the new cars is from 30,500 to 31,300 lb. This weight compares with 37,400 lb. for the Talgo train and 110,000 lb. for the lightest standard coach previously built. Weight of the normal passenger car in this country is about 135,000 lb.

The Michelin light alloy train, which also utilizes pneumatic-tire wheels, was built by Compagnie Industrielle de Matériel de Transport to the design of Ateliers de la Rhonelle.

British Cold Welding Process Now Licensed for U. S. Use

A method of welding some nonferrous metals, but primarily aluminum, at room temperature is now being introduced to this country by a new company, the Koldweld Corp. The joining method, developed by General Electric Co., Ltd., of England, was described in detail in the November, 1948 issue of MATERIALS & METHODS.

The most essential detail of the process is that the aluminum surfaces to be cleaned are entirely free of their oxide films. The surfaces are then forced together under pressure in tools which are designed for the process. Three different techniques are in use to produce a straight weld, a ring weld and a continuous seam weld.

The process is owned by the British General Electric Co., but will be represented in the United States by the Koldweld Corp. The U. S. representative will license interested companies to use the process. Engineering services will be offered along with the licensing arrangement, which will cost users approximately ¼ of 1 cent of the cost of the welded piece.

Metal Congress Papers Present New Data on Behavior of Materials

More than 40 papers were presented at the 31st annual convention of the American Society for Metals, held in October at Cleveland, Ohio. The principal conclusions of those papers believed to be of most interest to our readers have been briefly summarized below.

Ductile Zirconium

The development of zirconium as an engineering metal has been similar to, but slower than, that of titanium. Now, however, research by E. T. Hayes, E. D. Dilling and A. H. Roberson, of the Bureau of Mines, has produced extensive data on "Fabrication and Mechanical Properties of Ductile Zirconium."

Zirconium metal produced by reducing the chloride with metallic magnesium has been forged and rolled at 1560 F to satisfactory sheet and rod by protecting the metal from oxidation with an iron sheath. Equally satisfactory sheet can be produced by hot rolling the forged ingot at 1200 F in air. The metal can be successfully drop-forged and stamped, using standard commercial dies and equipment, and swaging and drawing are also possible.

Tensile strength of sheet rolled at 1560 F was increased from 63,500 to 93,500 psi. at 60% reduction with no evidence of overworking. Rockwell B hardness was increased from 86 to 98 with over 70% of the work hardening occurring during the first 20% of cold reduction. Elongation dropped from an initial 14 to 8.5% at 20% cold reduction and then remained constant to 60% cold work.

For sheet prepared by rolling at 1200 F, annealing caused tensile strength to drop from 86,400 to 80,000 psi. at 750 F and to 59,000 psi. at 1290 F. Temperatures up to 2010 F did not materially decrease this value. Yield point values decreased from 64,400 psi. at 750 F to 33,800 psi. at 1470 F and then increased to 40,500 psi. at 2010 F. Elongation increased from 9% for the cold-worked material to 14% at 750 F, 27.5% at 1290 F and 29% at 2010 F. Complete stress relief occurred at 930 F, with recrystallization complete at 1110 F.

Heat Treating Aluminum

In "Effects of Quenching Rate and Quench-Aging on the Tensile Properties of Aluminum Alloy 61S," R. C. Lemon and H. Y. Hunsicker, of Aluminum Co. of America, discussed the merits of a heat treating procedure termed "quench-aging" compared with the conventional quenching and aging of 61S. In the quench-aging process, the alloy is both quenched and aged in molten salt at a temperature in the 300 to 400 F range; in this investigation, temperatures of 320, 360 and 400 F were studied.

At comparable quenching rates, the tensile strengths obtained by quench-aging were higher than those produced by the conventional procedure when a few hours of natural aging elapsed between quenching and artificial aging. However, specimens quenched in cold water and immediately heated to the artificial aging temperature had higher properties than quench-aged specimens under comparable conditions. This was attributed to the lower cooling rate in molten salt.

The authors believe the quench-aging procedure might be of some commercial interest from the standpoint of eliminating the detrimental effects of natural aging between quenching and aging at elevated temperatures.

Fatigue, Damping and Elasticity

Some results of a research program for correlating fatigue, damping and elasticity behavior of materials and structures under sustained cyclic stress were given by Professor B. J. Lazan of Syracuse University in a paper entitled "A Study with New Equipment of the Effects of Fatigue Stress on the Damping Capacity and Elasticity of Mild Steel."

Generally, cyclic stress below 80% of the fatigue limit has little effect on damping and elasticity, whereas stress applied between this cyclic stress sensitivity limit and the fatigue limit increases damping as much as 2500% and reduces the modulus of elasticity as much as 11%. Cyclic stress above the sensitivity limit not only increases damping capacity at that stress but also at all other stresses. Cyclic stress above the fatigue limit has even more pronounced effects. Rest at zero stress after prolonged constant cyclic stress above the cyclic stress sensitivity limit may cause a substantial decrease (up to 45%) in damping capacity and an increase (up to 3%) in dynamic modulus of elasticity.

The observed negative cyclic stress sensitivity for dynamic modulus of elasticity is proposed as an explanation of the dependence of fatigue

(Continued on page 130)

Dow Evaluates Consumer Applications of Plastics

Molders using plastics products of Dow Chemical Co. are being offered the services of a company technical committee to evaluate products. The committee checks the plastics products from the standpoint of basic design, molding techniques, comparison with other plastic and non-plastic materials, and resistance to potential service hazards. No attempt is made to consider the product aesthetically or from the sales standpoint.

Products meeting the committee's standard are permitted to use an identifying label. When results are not up to standard, suggestions for improvement are given the molder. Dow officials report a ready willingness on the part of molders to accept suggested product changes.

Zirconium Boride Compound

Continuing research on the problem of finding materials capable of withstanding high temperatures encountered in turbine and rocket power plants has resulted in the development of zirconium boride, a new metallic compound.

The new alloy was developed under an Office of Naval Research contract by American Metals Corp., Yonkers, N. Y. In recent tests, this material has survived higher temperatures than any material previously used in the experimentation. Further tests of the new material are now underway.

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High Corrosion Resistance Gives Nickel Plated Metals Wide Range of Uses

by W. H. PRINE, International Nickel Co.

In making industrial equipment, nickel plating can provide an economical solution where service conditions do not justify use of solid corrosion resistant materials.

• IN A GREAT NUMBER of industries, the corrosive properties of materials in process have a detrimental effect upon the processing equipment. This gives rise to two problems: excessive maintenance and accelerated deterioration of the machinery and contamination of the finished material by the products of corrosion. These problems can only be eliminated by constructing the processing equipment from corrosion resistant material, or by protecting the base metal parts with a suitable covering. Frequently, the degree of corrosion is not of sufficient importance to warrant construction of solid corrosion resistant material, but an economical solution to the difficulty could be in the use of a sound protective armor of electrodeposited metal to shield the base metals commonly used for construction.

Because of the good corrosion resistance of nickel to a wide variety of products, nickel deposits are being used in various industries to prevent equipment deterioration and produce contamination. Deposits can be used as thin as 0.003 in. and as thick as 0.080 in. The former thickness is for mild usage where corrosion of the base metal is not severe and the principal interest is in covering up a possible source of undesirable metallic contamination; therefore, in the event of a break through of this relatively thin coating, the attack of the base metal will be on a restricted area and product contamination will be negligible. If a deposit should abrade or corrode through, the unit can be replated in a manner similar to the cycle used for the initial deposition. The heavier deposit is made where both wear and corrosion are critical factors.

Greater deposit thicknesses, as much as 0.20 in., can be applied, but these are essentially for building up worn or mismachined parts. Building up with heavy nickel deposits can be utilized to restore the original dimensions as well as to produce a corrosion resistant finish, but these applications incorporating "build up" will not be discussed in this article.

Under controllable conditions, nickel can be deposited to exhibit the following range of physical properties:

Tensile Strength	50,000-152,000 psi.
Hardness (Brinell)	140-425
Ductility (% Elongation in 2 In.)	30%-6%

The high tensile strength and good ductility of nickel deposits make them shock resistant and assure adequate adherence to the base metal when properly applied. In addition, electrodeposited nickel is readily machinable and can be ground and polished to a high finish if desired.

Highly polished nickel plated drum used in manufacturing photographic film. (Courtesy Eastman Kodak Co.)

These good physical properties, along with the high degree of corrosion resistance in many environments, in conjunction with the versatility of applications to various base metals, provide an economical solution to corrosion problems of many industries where equipment deterioration and product contamination are of importance. The examples where nickel deposits are used for corrosion resistance and protection against wear and abrasion are many and varied, and can be discussed most systematically when classified according to industry.

Paper and Pulp Equipment

To take advantage of the corrosion resistant properties of nickel in the paper industry, wire return rolls, kamyr rolls, table rolls, primary press rolls and sweat dryer rolls are being plated with adequate nickel deposits. A deposit of 0.010 to 0.030 in. is employed, dependent upon the service. Rolls are balanced, plated with the required thickness of tough, adherent nickel; then the nickel deposit is ground and polished to a high finish. In some instances, grinding of the deposit is not necessary.

This nickel deposit can be produced to a hardness of 425 Brinell with a bond strength exceeding the tensile strength of the cast iron base. The wear resistant surface preserves maximum heat conductivity of the drier rolls because of the good bond between the base material and the cover. The fine polished surface (retained because of the hardness of the deposit and its resistance to corrosion) lessens the tendency for the accumulation of slime, pitch and fibre.

Plating equipment for processing these rolls is usually designed with flexibility to accommodate a wide variety of combinations in roll length and diameters. Rolls as small as 3 by 96 in., as well as long ones 8 by 272 in. and large diameter ones 60 by 156 in., have been processed by the Union Screen Plate Co. of Lennoxville, Quebec. In this country the Chromium Corp. of America, Waterbury, Conn., and Chicago, Ill., are equipped to process rolls of comparable size.

Proof of the serviceability of nickel plated rolls is evident in the fact that nickel plated wire return rolls have been in service at the Manitoba Paper Co., Pine Falls, Manitoba, for 21 years, and primary press rolls have been in service in the U.S. for 8 to 10 years without replating or even regrinding.

The large sizes of conduit required to handle the great volumes of water in a paper mill frequently makes it uneconomical to employ solid corrosion resistant alloy pipe. For this application, standard (20 to 30 ft.) lengths of pipe in diameters up to 24 in. can be nickel plated internally to produce the required corrosion resistance. This pipe normally bears a deposit of 0.005- to 0.010-in. thickness, but any thickness can be supplied.

Bronze screen plates have been nickel plated to provide a better wear resistant and corrosion resistant surface and to fill in the slots for resizing. Beater bars are plated to prevent seizing, and save-all trays are protected from corrosion attack when plated with a serviceable layer of nickel.

Food and Beverage Industry

Nickel is unattacked by most foods and beverages, and in the event that there is some limited solution of nickel, it has been proven to be nontoxic. To prevent equipment corrosion and improve the purity of the product, heavy industrial nickel deposits are being employed in an expanding number of applications.

Heating kettles of copper construction used for cooking tomatoes have failed in one season and given unsatisfactory service during that time because of difficulty in cleaning. After nickel plating the internal surface with 0.010-in. nickel, they are still giving satisfactory service after their third season. These kettles are 4 ft. in dia. by 6 ft. in depth.

In the dairy industry, it has been common practice in the past to tin the copper tubing used in the construction of pasteurizer coils. In 1947, several coils were nickel plated (0.008 to 0.010 in.) and installed in service, where they have been giving satisfactory performance. The chief advantage of nickel plating over tinning is that the nickel is harder and withstands the abrasive action of the stainless steel scouring sponges. This gives a longer, protective coating life and permits quicker and more efficient cleaning techniques. The satisfactory performance of this initial installation of nickel plated coils has led to similar practices in other dairies where the same coil is used for both heating and cooling cycles during the pasteurizing process.

To give 100% protection where corrosion resistant alloy or clad material is used for the large containers, internally nickel plated pipe and fittings as well as pumps are being tested. To prevent iron pick-up in a brewery, a pump was recently plated on all surfaces which came in contact with the beer. If this proves satisfactory, additional pumps and other auxiliary equipment will be protected by plating in a similar manner.

In addition to the advantage of good corrosion resistance, nickel deposited with a hardness up to 425 Brinell produces an abrasion resistant surface as well. Plating for this application offers these advantages in the design of both the screw and the cylinder. There is also a potential market for preplated nickel strip for conveyors in the baking industry.

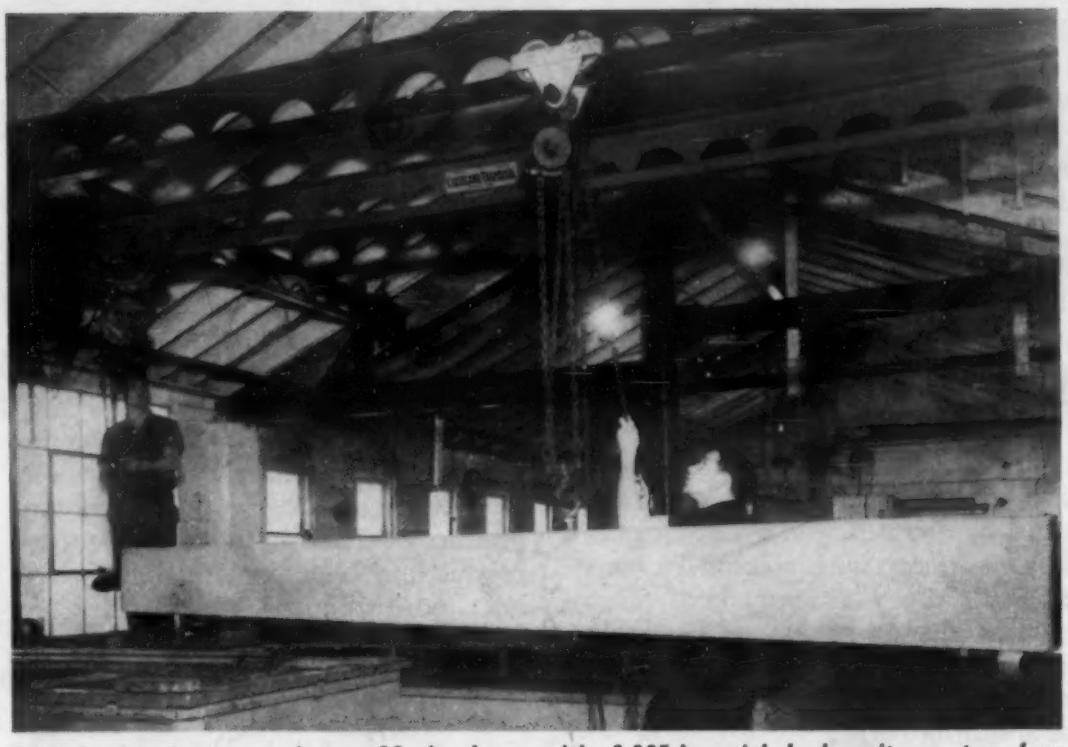
Other units, such as nickel plated apple pulpers, meat hooks, candy molds, autoclaves, etc., illustrate the wide variety of application in the food industry where such a coating proves advantageous.

Petroleum Industry Equipment

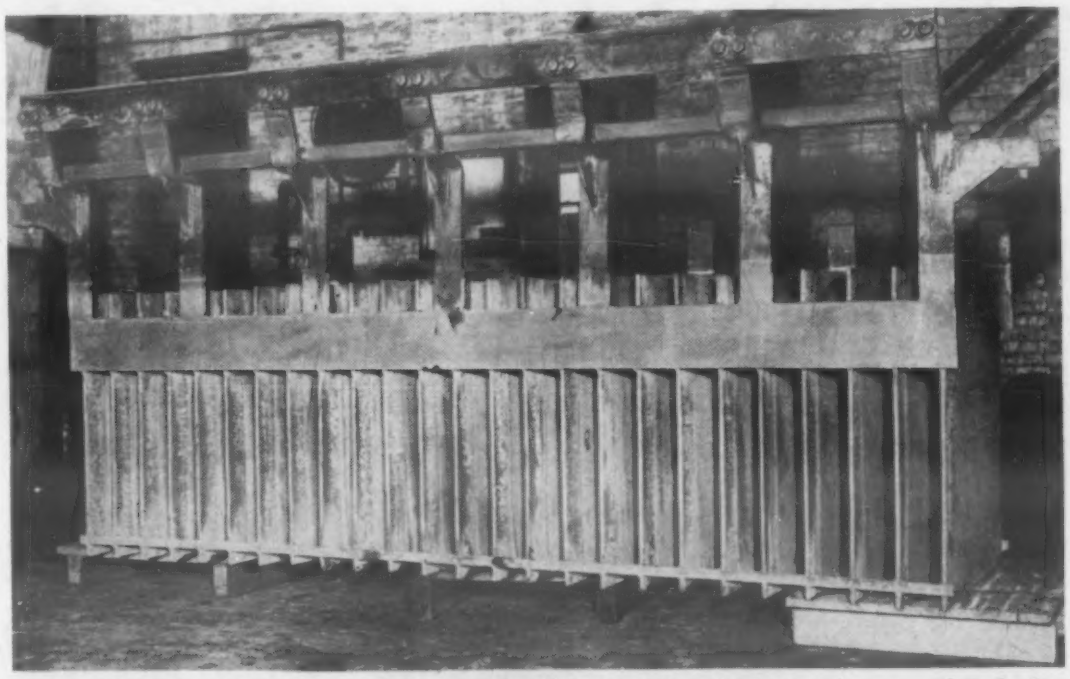
In order to keep abreast of the increasing demand for petroleum products, the oil industry has had to rely on production from the "sour" oil wells. The presence of hydrogen sulfide along with carbon dioxide causes the sour crude oil to be very corrosive to oil well tubing and requires some means of protection. This gives rise to a potential field of application for nickel, which is well suited for use in these corrosive media.

Over 30,000 lineal ft. of 2- to 2½-in. tubing have been internally nickel plated for installation in distillate gas wells where these extreme corrosion conditions are encountered. These orders were placed on the basis of the excellent performance of sample lengths of the plated pipe which showed no effect of corrosion while a carbon steel pipe was severely corroded. One 10,000-ft. length of plated tubing has been installed in a well which is sunk several miles off shore in the Gulf. This tubing has been given a nickel deposit of 0.006 in. Plating is regulated so as to plate over the outside threads on the ends of the pipe to protect them. The couplings are also plated internally, giving full protection to the surface in contact with the oil.

Nickel plating is being tested for protection of the field storage tanks. These tanks are of "bolted" construction. Since just the bottom and lower

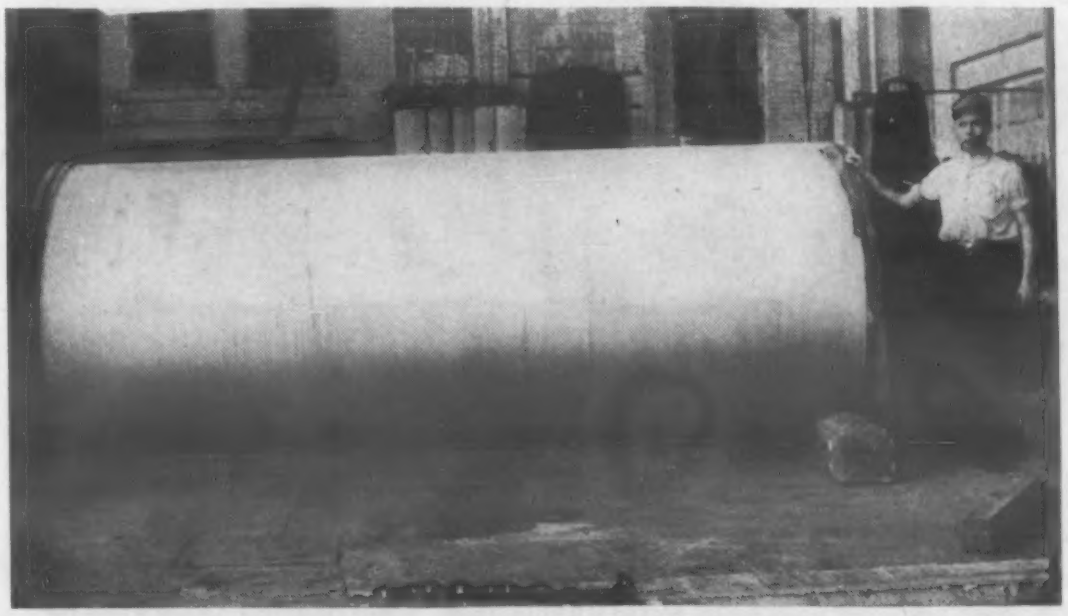


Nickel plated steam platen, 18 ft. long, with 0.085-in. nickel deposit on top face. (Courtesy Plating Engineering Co.)



These electrodes are used for tin recovery by Metal & Thermit Corp. They are plated after assembly and measure approximately 54 in. by 54 in. by 12 ft. (Courtesy Chromium Corp.)

Sweat dryer roll, 60-in. dia. by 156-in. face, nickel plated to a thickness of 0.030 in. (Courtesy Union Screen Plate Co.)



sides are subjected to corrosion, only those sections are being plated. This provides the most economical means of construction, giving protection only where it is required. Acceptance of this application can lead to nickel plating of the roof section, where corrosion also occurs in the vapor phase.

Textile Industry

It has been common practice among some rayon manufacturers to have the cast iron filter plates protected by depositing a layer of nickel on all surfaces which come in contact with the viscose material. This prevents the formation of insoluble iron salts, which clog the spinnerettes and cause production difficulty in the spinning baths.

As with the filter plates, some protection is necessary for equipment handling the liquors prior to the spinning of the thread; therefore, samples of internally nickel plated pipe have been installed. This pipe is protected with 0.006-in. nickel, and results to date indicate that it is suitable for the application.

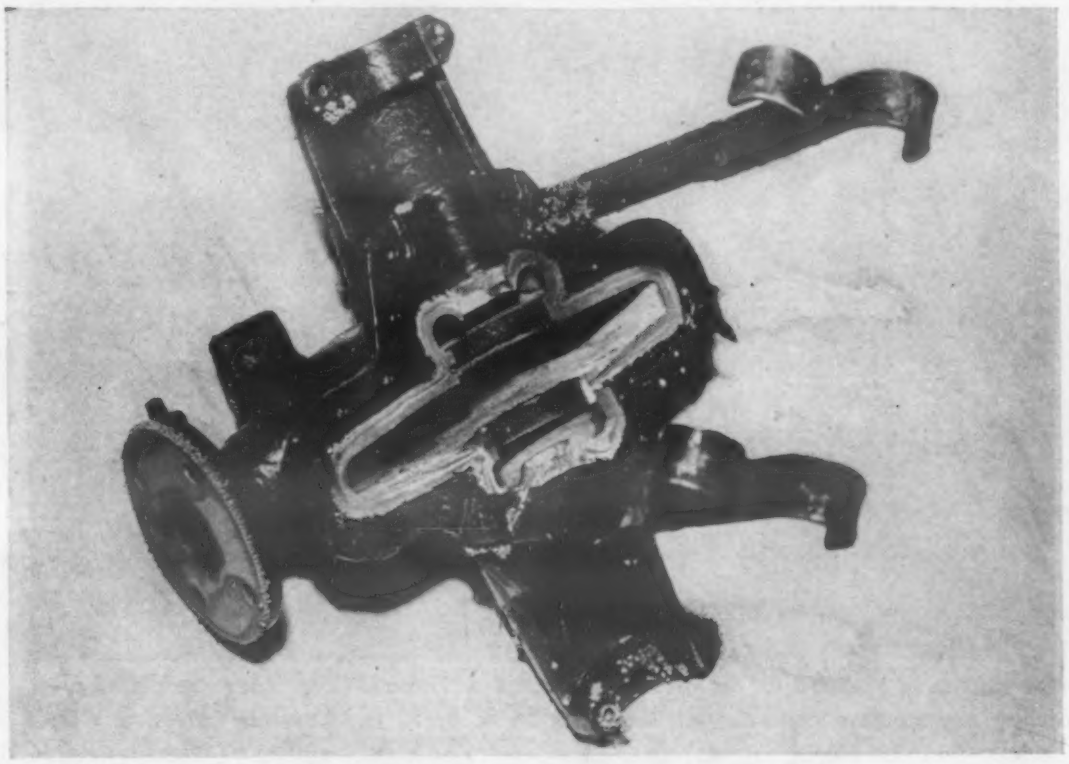
Other applications of heavy nickel deposits are on bobbin trays, immersion rolls, dry cans, dye sticks, and other pieces of equipment where, although the corrosion rates are not too detrimental to the equipment, still the minute products of corrosion are detrimental to the quality of the product or interfere with continuous production. Nickel plating also permits more thorough cleaning.

Plastic Industry

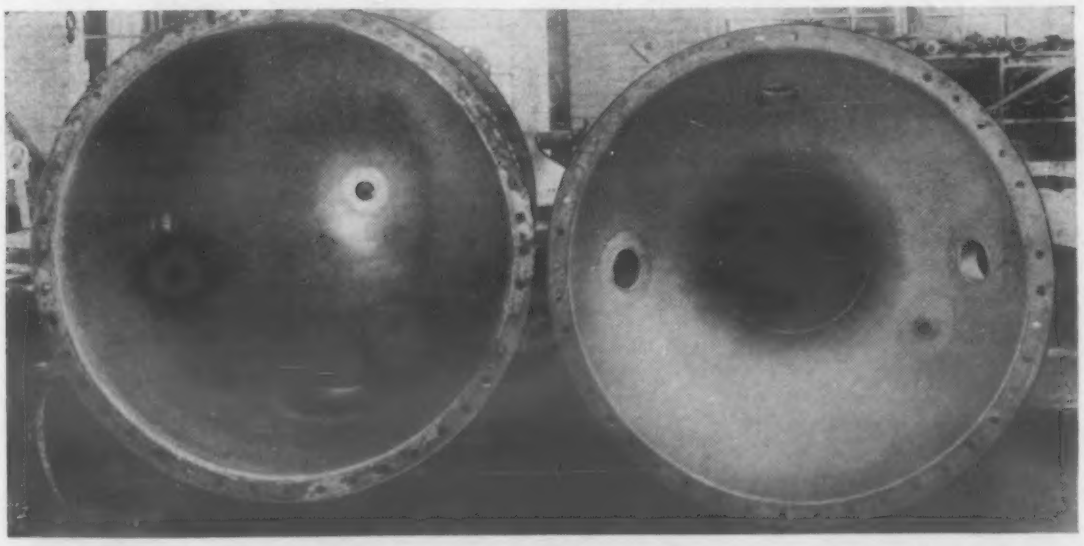
It has been found advantageous to nickel plate cast iron or steel drums that are used in the production of photographic film. Copper and other metals corrode and contaminate the product whereas nickel withstands the attack. The surface finish must be so perfect that wrought metals cannot be used because of inclusions; therefore, the homogeneous nickel deposit offers another advantage.

Nickel plating has also been used to advantage on press plates. The largest unit of this nature that has been plated by the Plating Engineering Co. of Milwaukee was a hollow steam platen bed plate for pressing and forming insulator strips for electrical generators. This plate, 18 ft. in length, was plated with a 0.090- to 0.100-in. nickel deposit, which was ground to 0.060 in. Plating was for protection against moisture and chemical attack. A special plating tank was built to do the job.

It is common practice to plate the surfaces of molds for casting plastics. Although chromium plating presents some advantages because of its extreme hardness, nickel is also employed for cavities used in molding plastics which are corrosive to chromium and stainless steel. For this application, hard nickel deposits are used.



Beer pump internally nickel plated on all surfaces coming in contact with the liquid. (Courtesy Plating Engineering Co.)



Vacuum pan (interior view) used in processing tomatoes. It is approximately 48 in. by 74 in. deep, with inner walls nickel plated 0.010-in. thick. (Courtesy Union Screen Plate Co.)

Other Applications

In soap and allied industries, machinery structures have been protected by nickel plating to control the color of the soap which would otherwise be discolored by corrosion products. Heating kettles and fatty acid stills are other examples where economical protection was provided by plating.

One difficulty encountered in the performance of air cooled transformers is that the copper wire grids tend to oxidize, and this oxidation lowers the rate of heat dissipation. This problem is solved by nickel plating the wire to prevent oxidation.

The Chromium Corp. deposit 1/32 in. of nickel on roller pins or axles for penstock gates. These pins vary from 6 to 10 in. in dia. and from 13 to 22 in. in length. Rolls mounted on these pins guide the gates in opening and closing. The nickel plating provides a corrosion resistant surface which assures that the rollers are always free to turn in controlling such dams as Grand Coulee, Pickwick, Bonnerville and others.

In the leather industry, frequent use is made of heavy industrial nickel deposits for protection of the squeeze rolls and press plates and for obtaining certain types of finishes.

Spinning of Difficult Shapes Simplified by Use of Speed Chart

Thicker sections, larger diameters, and variety of metals can now be spun using advanced techniques.

by **HERBERT E. EDLUND,**
Roland Teiner Co., Inc.

• UNTIL RECENTLY, many shapes difficult to form by other methods were also too costly to be produced by spinning. The operations involved were known to a small group of expert spinners, and this complicated the problems of high speed, low cost production. Now metals can be spun commercially into intricate and difficult shapes, as a result of a series of operation studies of speed, diameter and material.

The first of these studies, carried out by Roland Teiner Co., Everett, Mass., pertained to a charting of actual case histories of metal thicknesses, diameters and spinning speeds. One of the initial problems encountered was to find a method of handling metal thicknesses. In studying the various methods, it became evident that there is almost a true geometrical pattern behind the gage designations used for indicating metal thickness. Thus, there are as many gage numbers between 0.005 to 0.010 in. as between 0.08 and 0.016 in. Here 0.005 to 0.010 is a 0.005 range wherein there are six gages, each as important to the metal working man as the next six in another range. For example, the range of 0.08 to 0.016 in. is a 0.08-in. range which is 16 times as thick as the 0.005-in. range, and yet it has only the same number of gage points.

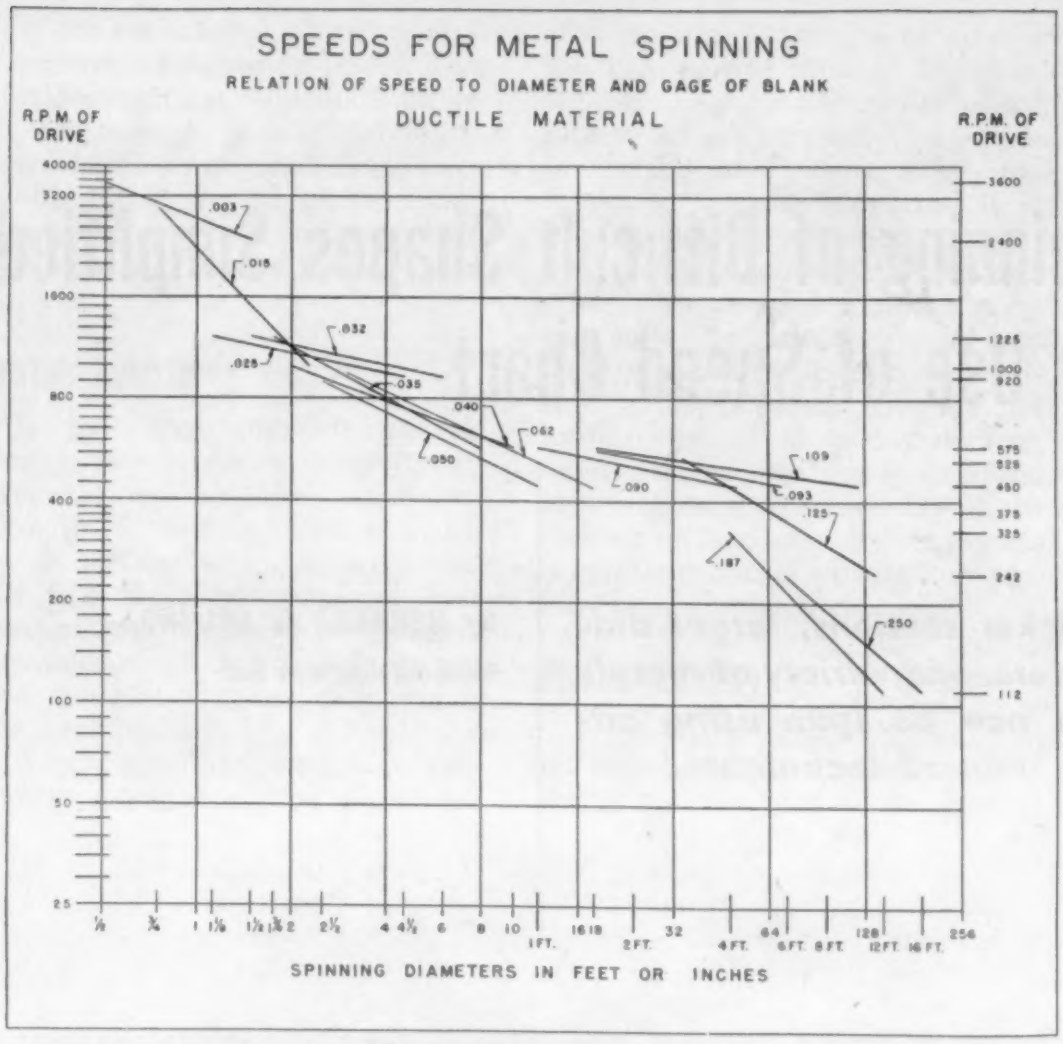
Applying this geometric type of relationship to the charting of diameters as well as thickness made possible a basis for the first chart. This chart was made by listing the most significant case histories in a table form and then interpolating from the table to the chart. However, with an enlarged copy of the chart placed in the shop, and with increased shop interest, the use of a table to list data for charting was eliminated. Flags, placed directly on the points of gages and diameters of actual case histories, permitted the shop to see the speeds used by others for significant cases.

Direct Reading Chart Developed

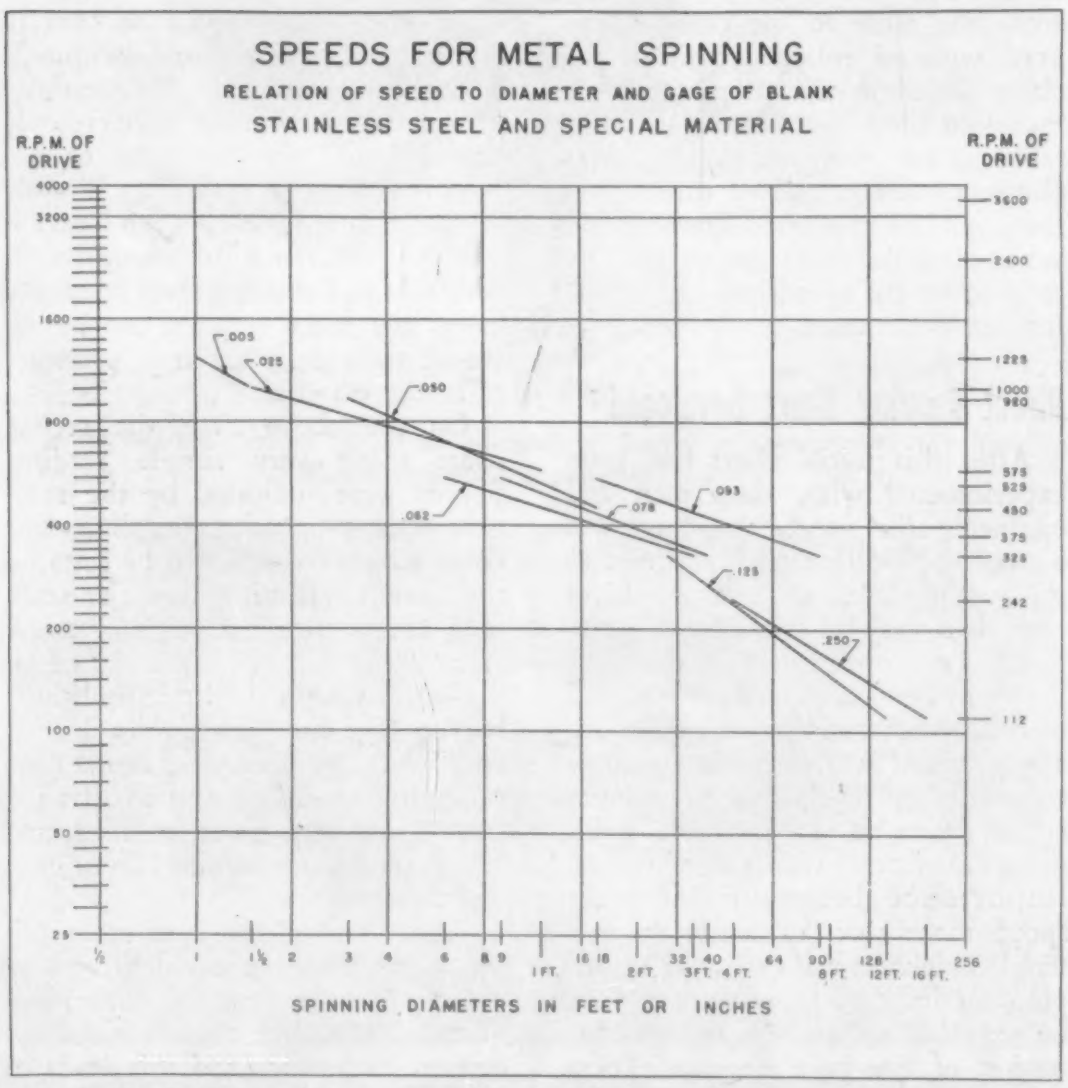
After this initial chart had been experimented with, shop men and engineers alike agreed that there was a need for a direct reading chart, to guide spinners to the average thickness, diameter and speed for any material. To accomplish this, the facts shown by the first chart were arranged in their order of importance. For example, speed was given first importance because revolutions per minute is the figure needed for metal spinning. Diameter was given second importance because it influences speed more than thickness or material. Thickness was then given third place in importance because, as can be seen from the slope and concentration of the gage lines, thickness has little effect on the optimum spinning speed. For example, a heavy piece of metal is rarely used to spin a very small diameter. In the same way, the cases are rare in which a light gage is used for large diameters. Thus, the diameter can be said to control the speed range, within a smaller range for each common size of metal gage. Finally, material was placed fourth in this order of importance. Speeds vary only slightly with different materials, and except for the difference between ductile materials and stainless steel or special cases, any speed selected can be adjusted sufficiently by tool pressures to fit the material.

On the above basis the second chart made very simple reading. Speeds were indicated by the same geometric proportions as diameters. Gage ranges were shown by lines on the chart, indicating that the common use of a certain gage of metal is normally limited to a range of diameters within the limits indicated by the gage line. From shop experience and case histories, these gage range lines were charted so that the new chart was easier to read and speed could be determined from gage and diameter.

From these charts, and other observations, there appeared to be several speed ranges for the same piece of metal, the same thickness and diameter. However (and this leads to one of metal spinning's trade se-



Direct reading chart giving proper speeds for spinning ductile materials.



Direct reading chart giving proper speeds for spinning stainless steel and special material.

crets), there seemed to be a best speed for each material for a standard operation. On this basis, the relationship between thickness, diameter and metallic composition appeared very nearly in line with a simple curve. The curve would probably be almost formula exact if it were not for the limitations of the different speed groupings that are available on different machines.

Additional studies were made to simplify the spinning of difficult shapes, and from these studies, operation charts were sketched out in rough form. The charts (not shown) indicate that speed becomes most exacting when the metal being formed has to meet very close tolerances.

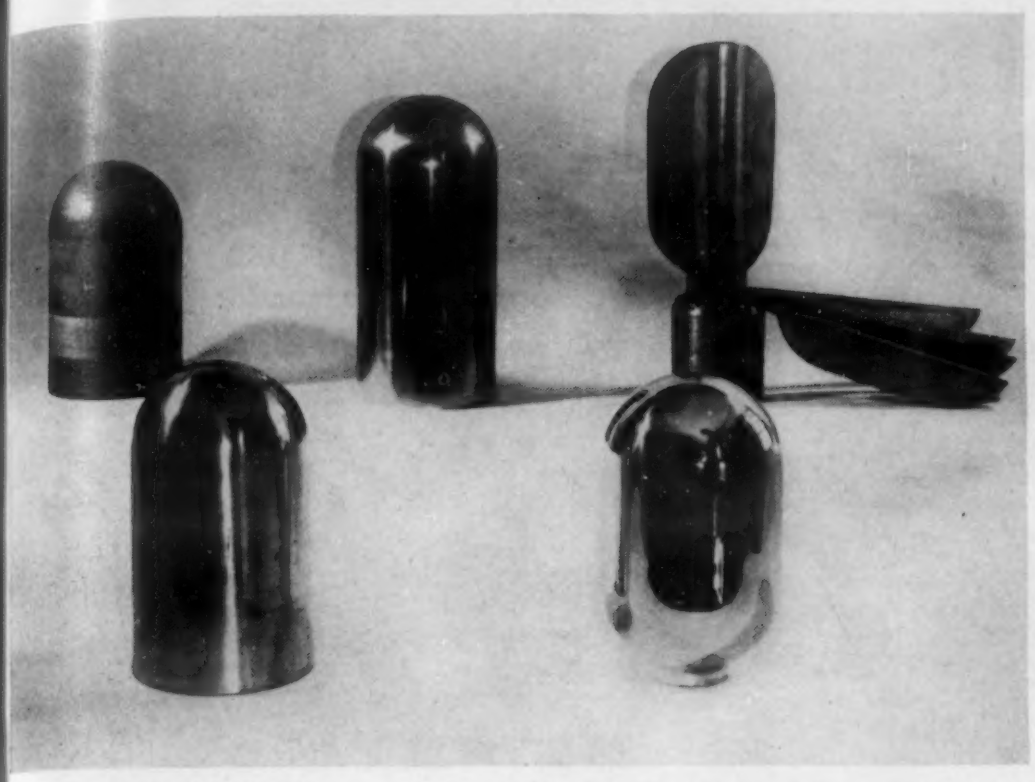
One of the interesting case histories of an unusual shape formed by spinning is that of an inverted cylindrical section made for Greer Hydraulics, Inc. The service performance of this "bottle" required that it be made of a solid piece of seamless metal of uniform thickness. Previous ones spun in two sections and joined with a welded seam had proven unsatisfactory. As metal workers know, the problem of spinning an inverted cylindrical section is more difficult than that of spinning a conical section. In the case of sections having the characteristics of a bottle, a complicated sectional form assembled from separate pieces is used. In spinning, the narrow neck and o.d. diameter combine to determine the size section that can be used in the make-up of such a form. The smaller the neck, the smaller must be the o.d. diameter.

Thus, in the case of the "bottle" it was necessary to make a series of forms which would permit close tolerance work within the required specifications. The tool designers were able to do not only this but also to create a spinning form of a number of pieces that permits the finished, spun bottle to be taken off, and the pieces reassembled for use in quantity production.

The same studies have assisted in the spinning of other unusual shapes and formations. Some of these include radar antennas, metal tubes for television, baseball night lighting reflectors, and parts for jets and guided missiles.

Advantages of Spinning

The recent war accelerated the development of advanced spinning techniques, and it is now possible to spin almost all metals, heavier thick-



An inverted cylindrical section made by spinning showing forms and sequence of last operations.

nesses and larger diameters. Because of these advances, post-war industries are finding spun parts a practical answer to problems of reduced costs, improved products and speedy entrance into consumer markets. There is no long delay necessitated by the setting up of dies and presses, and the intricate shapes can be made without extra operations.

Unless quantities run into the thousands of pieces, it is frequently cheaper to spin the articles than stamp them. With stainless steel and high chromium materials even small quantities are economical. Furthermore, spinning can be combined with welding to produce an extensive line of parts.

Virtually any metal or alloy can be spun—aluminum and its alloys, steel, stainless steel, copper, bronze, brass, nickel, magnesium, Everdur, Monel and Inconel. In addition to sheet metals, great strides have been made in the spinning of tubing. Expansion and reduction can be accomplished by cold spinning, but the application of heat widens the range. Contrary to popular belief, it is not necessary that large quantities be involved to utilize hot spinning.

Advances have also been made in increasing the diameters spun. By using high speeds for small blanks and then testing progressively slower speeds for large sizes, actual speeds and new techniques have been developed for many parts. For example, 16-ft.-dia. blanks can now be spun, and the possibilities for even larger sizes have not been exhausted. From a practical viewpoint, there may be a limit. The larger the blank, the greater the inertia and momentum. The greater these forces, the more critical becomes the shape and use of the tool. With large work, ordinary tools are not enough. Tools are usually made of hickory for the first operation of laying the metal down against the form. Then a tool of high-carbon steel forged to shape and fastened to a hardwood handle can be used to lay the metal up against the form. When large sizes and special deformations are involved, these tools are not adequate and the spinner must design special tools. Mechanical contrivances become increasingly important and each job requires its own tool engineering. For the larger jobs, lubricants such as soap, oils or greases are required; smaller sizes can use beeswax, tallow or petroleum jelly.

Many a production problem has found metal spinning as an answer. Today, with emphasis on speed, accuracy, fit and strength have assumed new importance, and old problems are being re-solved by metal spinning.

Spinning baseball night lighting reflectors.

Aluminum Used Successfully in Precision Instruments

A PICTORIAL STORY

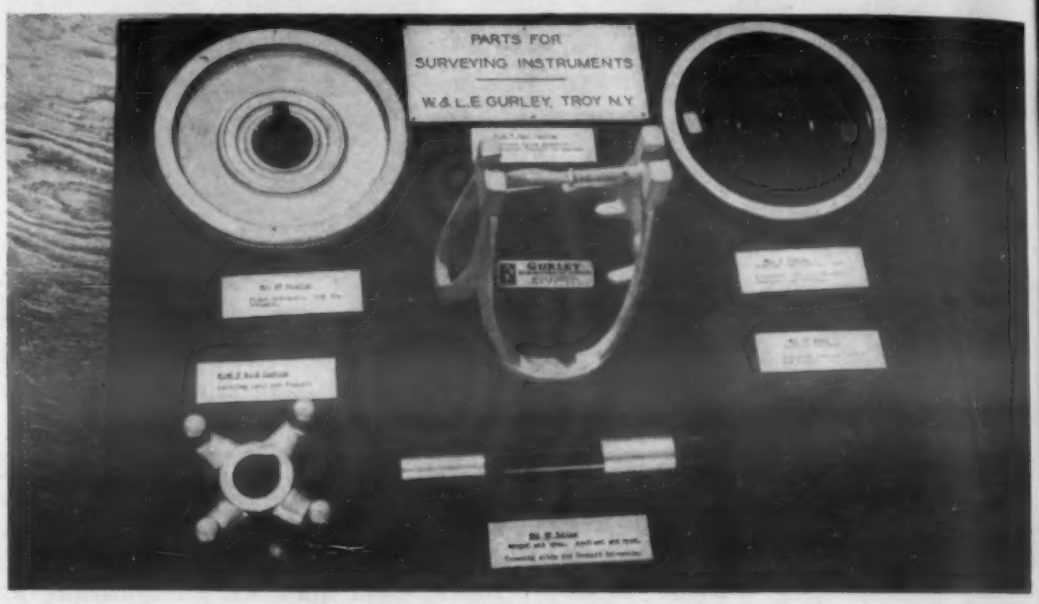
Requirements of accuracy during a long service life are controlling factors in selection of materials for engineering and surveying instruments.

● IN THE MANUFACTURE of precision instruments, the selection and careful processing of materials is of prime importance. Accuracy as well as long service life with a minimum of adjustment and repair are the quality standards that must be met, and to meet them, astute materials engineering coupled with expert workmanship are required. Perhaps no better example of the combination of these two factors can be found than at W. & L. E. Gurley, Troy, N. Y., where precision instruments are produced not only for engineering and surveying, but also for other fields such as meteorology and aeronautics.

Copper alloys and aluminum alloys are the principal materials used in the company's surveying instruments. One of the earliest uses of aluminum in this country was in a Gurley transit 73 years ago. And since that early application, aluminum has proved satisfactory in an increasing number of instrument parts. The main reasons for adopting the use of aluminum were: (1) light weight; (2) relatively high strength and yield point; (3) lends itself to precision machining; (4) good ductility; (5) relatively good corrosion resistance, especially in sulfur atmospheres; and (6) does not distort nor "grow" with age. The aluminum alloys most used at present are 14SW, 61ST, 356 and 13. By proper selection and heat treatment the service properties can be varied to meet the requirements of each part.

While aluminum alloys are generally used for structural parts of Gurley surveying instruments, bronze is used for all bearing parts. Symmetry of design accounts for differences in expansion and contraction where metals of unequal co-efficient of expansion are used. Therefore, in adjacent parts care is taken to use materials whose yield points exceed any temperature strains that may be set up. A thorough test program insures against any differences in accuracy within a temperature range of —80 F and +165 F.

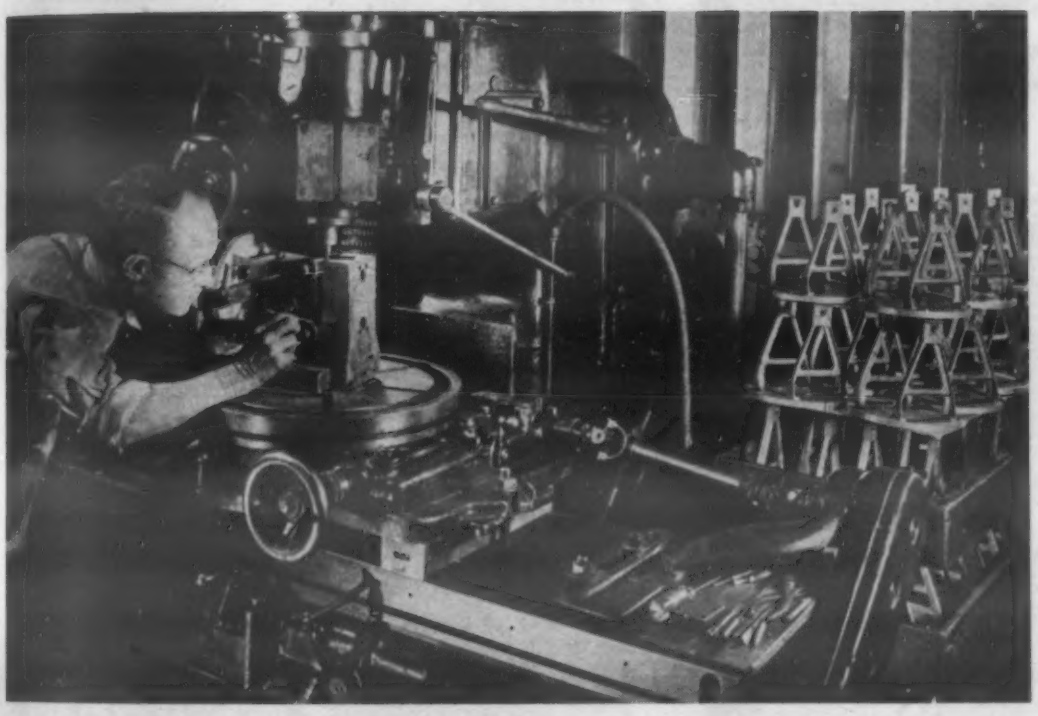
The accompanying pictures illustrate a number of the steps involved in the production of various parts making up the transit.



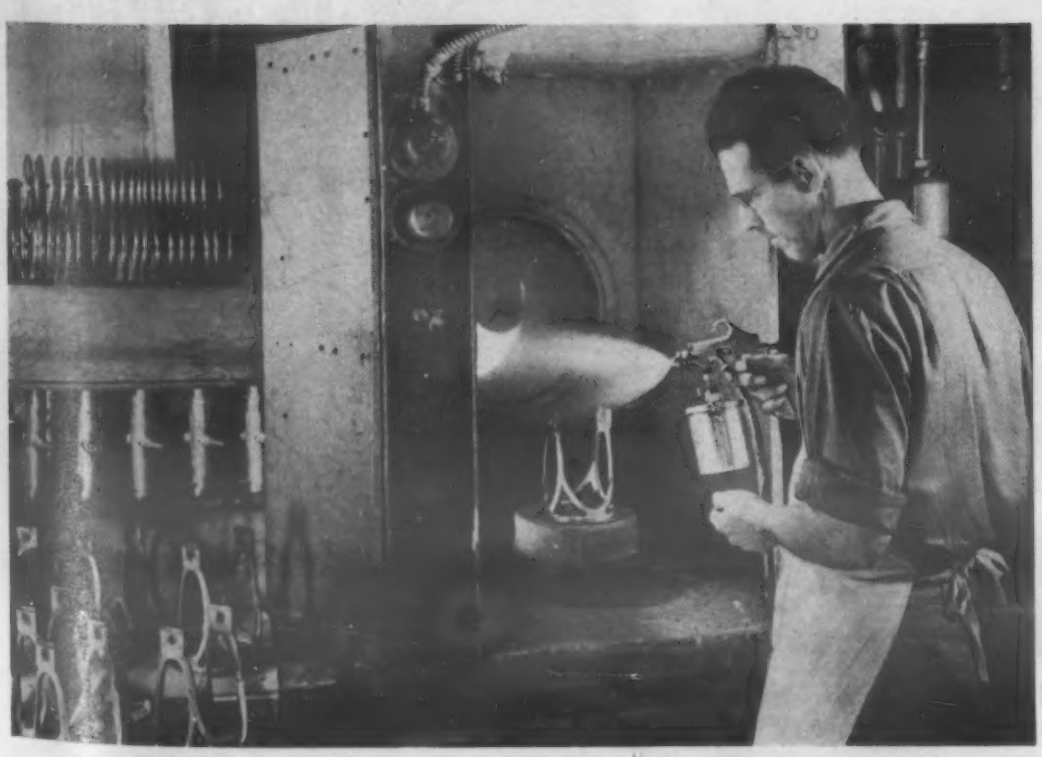
1—Shown here are the aluminum parts used in Gurley surveying instruments. At top, left and right is a 14SW forging for a horizontal transit limb before and after being machined, anodized and dyed. In the center is a sand casting of 356 alloy for the truss standard. Lower row, left to right, is a transit leveling head sand casting of 13 alloy, a swaged and spun tubing for telescope focusing slide of 51ST alloy, and a graduated vertical circle made of 61ST aluminum sheet which has been anodized and dyed.

2—Sand casting aluminum alloys for precision instrument parts requires proper design of molds and careful control of melting and pouring operations to insure dense castings free of gas and shrinkage porosity.

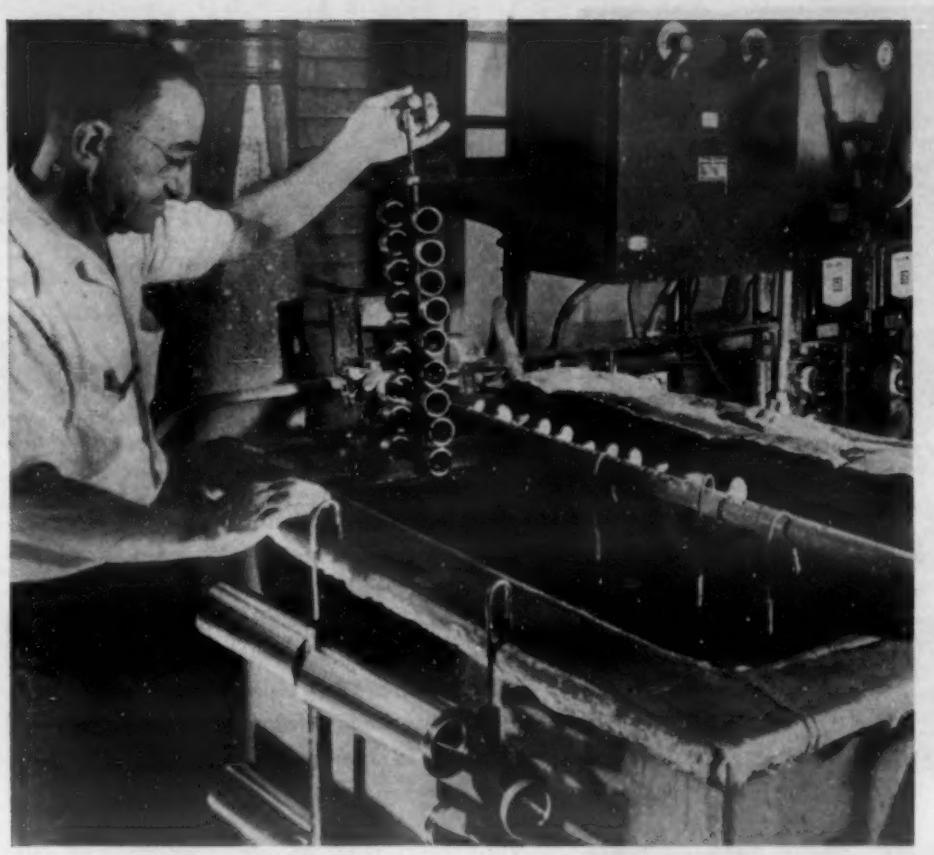
3—To obtain optimum mechanical properties, the high strength aluminum alloy castings are heat treated in this electric furnace. Aluminum alloys are first solution heat treated and then given a closely controlled artificial aging treatment to develop maximum strength and hardness and to remove internal strains.



4—Bearings for transits are hobbed in this machine. The bearing is a bronze block fitted to a carefully milled opening in aluminum alloy supports. Multigroove design of bearing increases bearing area, insures longer life, and resists lateral movement.



5—A primer coating of a synthetic resin in combination with zinc chromate is applied to the surveying transit part to provide a durable base for subsequent protective and decorative finishes. The primer coating is oven baked. The later coatings are air-dried.



6—Many of the aluminum alloy parts are anodized to provide a thin but extremely hard coating to resist wear and corrosion.

7—Glass reticles have replaced the old hair and wire types. Special ruling machines space lines to accuracies of 1 micron on the glass. Metallic filaments are then deposited on the reticle lines to assure equal visibility against either very bright or dark backgrounds.

8—High vacuum techniques are used to deposit hard fluoride coatings on surfaces of optical lenses.

9—Assembly of instruments, and fitting and adjusting requires expert workmanship.

Methods of Machining Laminated Phenolic Plastics

by GEORGE A. EBELHARE, Superintendent, Specialty Dept., Synthane Corp.

Good machinability is a characteristic of these materials, but for most efficient machining the techniques and practices given here should be followed.

• EVEN THOUGH GOOD machinability is one of the outstanding characteristics of laminated phenolic plastics, certain techniques and practices must be followed for most efficient machining of them. Therefore, a summary of the practices developed by Synthane Corp. and others should prove helpful to those concerned with improving their methods of fabricating these laminated plastics.

Products made from these materials can be machined without difficulty by using standard wood- or metal-working machinery. However, it should be borne in mind that phenolic plastics differ from metals in their basic properties. For example, they have lowered shearing strength, which allows high cutting speeds and feeds even on machines of light construction; they are more resilient, and so they require greater clearance and less rake on cutting tools. In all machining operations on these plastics, it is of greatest importance to keep tools sharp. Normally, all cutting is done without lubricants.

Depending on the grade or base of the material, it can be sheared, up to ⅛-in. thickness, with guillotine-type metal squaring shears. Up to 1/16-in. thickness in XP material, a paper-base punching stock, and up to ⅛-in. in most fabric-base grades, these plastics can be sheared at room temperatures (not below 50 F). Harder stocks can be sheared after heating to from 200 to 250 F, depending on grade and thickness. Heating should be uniform, and the material should be removed from the heating medium as soon as it reaches the required temperature.

Sawing

Simplest method of cutting phenolic plastics is with band saws. The standard woodworking band saw can be used for material up to 10 in. in thickness with file-hard, carbon steel blades or hardened steel blades with soft backs. Setting is important, and varies with different classes of work. Blades should have a medium set for straight cuts and a heavy set for circular cuts—the set increasing as the radius of the cut grows smaller. Recommended tooth range is from 3 to 8 points per in.; blades should be 18 to 20 gage, ¼ to ½ in. wide for circles, 1 to 1¼ in. for straight cutting. An automatic band-saw grinding or filing machine is recommended to keep blades sharp. On extremely heavy material from 3 to 8 in. thick, we recommend a blade with 3 points per in. Blades should operate at 5,000 to 8,000 ft. per min., and work should be advanced at a rate that allows for free cutting. Under no circumstances should the work be forced into the blade. Sharp blades, properly set, work not forced and guides kept low will safeguard against excessive blade breakage.

For smooth sawing, standard table-type sawing machines will work well at surface speeds up to 13,000 ft. per min. on material up to 1 in. in thickness where smooth edges and close tolerance are required, though greater thicknesses can be handled with special equipment and some care. Smooth blades without any set are preferred; choice of straight parallel sides or hollow-ground blades of carbon or high-speed steel, 1/16- to ⅛-in. thick and from 4 to 8 teeth per in., will depend on the thickness and form of the material. Teeth should be ground square with the axis for smoothest cutting. In sharpening, rounding the gullets at the bottom will help to free chips.

For each thickness and for various grades of stock, there is an elevation of the saw above the table that will reduce chipping to a minimum. Set the saw so that it just protrudes above the work; then adjust upward until the smoothest cut is obtained. Small tubing can be fed straight through the saw. Heavy-walled tubing over ¾-in. dia. should be "rolled" through the saw to prevent excessive break-out.

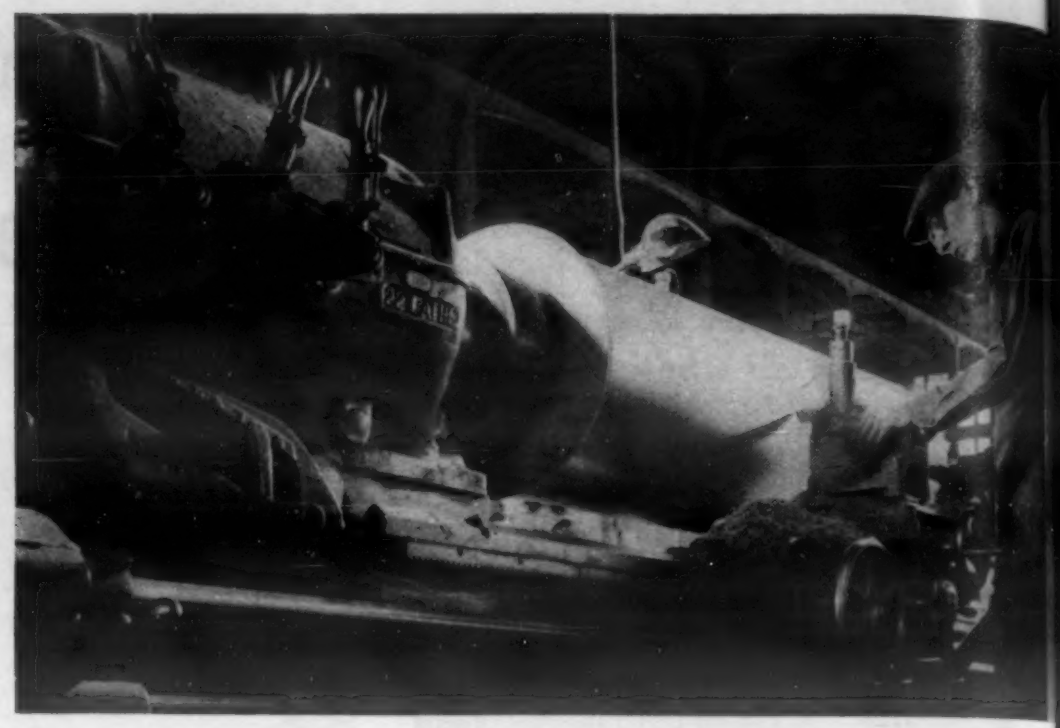
Abrasive wheels 1/16 in. or more in thickness can be used for cutting these plastics up to 2 in. thick, and are superior to steel blades for all glass base and most asbestos base materials. Machines used for dry cutting should be fitted with efficient dust-collecting equipment. A flood of water on the work and wheel can be used when necessary to prevent overheating and loading of the wheel.

Punching

Laminated phenolics can be punched, shaved and broached, again depending on the grade and thickness of material. Using standard power-driven vertical punch presses, punching produces a relatively smooth edge in thicknesses up to 1/16 in. Punching dies are practically identical with those used for metals except that little clearance is allowed between punch and die. Holes in the stripper plate also are a close fit to the punches, which helps

Regular twist drills can be used on laminated plastics, but for better chip clearance and higher production, special drills with a steeper twist and wider flutes will be found preferable.

Turning a large diameter of Synthane presents no special problems because the light weight of the material means little inertia.



prevent lifting of the material around the holes when the punches are withdrawn. The diameter of a punched hole should be not less than the thickness of the sheet. Also, the distance between punched holes, or between the edge of a punched hole and the edge of a piece, should be not less than 1½ times the thickness of the piece.

When designing a die for hot punching, allowance should be made for shrinkage. Synthane, punched when hot or warm, will contract when it cools, so all punches must be made larger than the size required. Increase in size depends on the size of the hole, thickness of the stock and its punching temperature. For high-speed production, progressive dies should be used whenever possible.

Some punching grades can be punched cold up to 3/32 in. thick. Harder grades will require heating in thicknesses from 1/32 in. up. Heating can be by hot plate, oven, hot oil or infra-red lamps; the degree of heat required will depend on the thickness and grade of the material.

Shaving, also in standard punch presses, is practical on material up to ¾ in. in thickness. Up to ⅛ in., it can be shaved cold. The degree of heat to be used on greater thicknesses depends on the thickness and hardness of the material. Often it is enough merely to take the chill off by heating to 120 F. Temperatures much beyond 250 F will cause burning and blistering, and will remove the high gloss finish. A piece of asbestos cloth placed between the hot plate or oven floor and the laminate will help to heat the material evenly and slowly without premature burning.

The shaving process gives smoother edges than are obtainable by punching, and provides a fast and accurate means of getting the desired shape on irregular shaped blanks too thick to punch. Any desired shape is worked out in a die block. The cutting edge is then beveled at 45 deg. on the outside of the die, leaving a knife-edge at the contour. The work is pushed through the shaving die by a soft steel or brass plate which does not enter the die.

Broaching can be done with hydraulic, motor-operated or hand-operated broaching machines, either vertical or horizontal, or on a standard punch press. Standard broaches with approximately 4-deg. cutting clearance and a slight positive rake are used. Except for this clearance angle, the broach is the same as is used for brass.

Broaches will produce square, hexagonal and other polygonal holes, irregular shapes, keyways, etc. However, the laminated structure of the material requires a special broaching procedure. When cutting across the laminations, the material must be backed up with a mild steel or brass plate which forms a slide fit with the last cutting tooth on the broach; this prevents fraying and breaking out of the edges. When cutting parallel to the laminations, use a fixture to apply pressure at right angles to the laminations. Teeth of the broach should be so spaced that, except for the beginning and end of the cut, at least two teeth will be in contact with the material. Ample chip room between the teeth, based on the depth of cut per tooth, should be provided. Use a tapered pilot pin as large as possible to facilitate rapid operation. Depending on the material and the type of operation, a cut of 0.001 to 0.005 in. per tooth can be taken, with the pitch ranging from ¼ to ¾ in.

Drilling

Drilling presents no particular difficulty. A regular twist drill will produce accurate work and do it efficiently. However, where high production is involved, we recommend the special drills for Bakelite, which can be purchased with a steeper twist and wider flutes—a type that provides more chip clearance. Maximum speed of high-speed drills should be 400 ft. per min.

Care must be taken to back up the hole so that the side where the drill comes through will be clean and free from burrs. Wherever the quantity will permit, a drill jig should be used, so designed that the top plate containing the layout can be clamped down hard on the plastic, holding it rigid with the bottom of the jig. Allow the drill to run into this bottom plate. Such a design, we have found, will largely eliminate breaking out at the bottom and lifting at the top. Drill in multiples wherever possible, with a total thickness not exceeding ½ in.

When drilling deep holes, back the

Large diameters, such as this 24-in. tube, are cut as readily as sheet. Note position of saw to prevent chipping.

drill out several times, especially if it is small. The average drill under No. 10 in size will tend to run off if the hole is much deeper than ½ in. Drilling at right angles to laminates can be done easily with a commercially ground drill. When drilling parallel with laminations, the drill tends to split the material. To prevent this, increase the included angle of the drill point and clamp the work securely with side pressure in a vise or drill jig. It is important to withdraw the drill several times when drilling parallel with laminations.

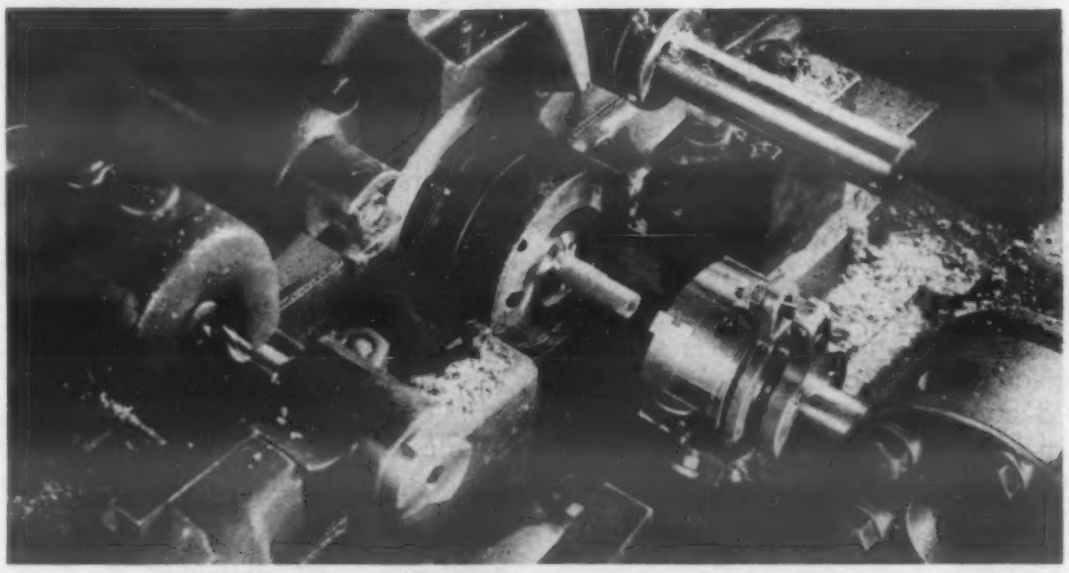
For countersinking, use a regular countersink, generally two-lipped and with negative rake up to 10 deg., or a twist drill. If a drill is used, it should have little clearance on the point; if a chattering action is set up, the cutting point should be broken on the inside of the flute.

Threading

Threads can be cut on a lathe or with taps and dies. Procedure should follow that used for brass. A small quantity of oil gives a cleaner thread. When threading in a lathe, fine cuts should be taken at high speed. Self-opening heads are desirable for quantity production. The proper die head also helps to guarantee a smooth, accurate thread.

Tapping should not be specified closer than a Class 2 fit with 65% to 70% of thread. Additional thread depth would add very little strength while introducing the risk of thread breakage. When tapping in a blind hole, allow a depth of several threads from the bottom of the hole to the first full thread, for clearance. Large holes parallel to laminations should be avoided where subsequent pressure, as from a screw, might damage the piece.

Laminated phenolic plastics can be punched cold in certain grades and thicknesses. Moderate pre-heating greatly facilitates punching and prevents hair cracks.



Rods and tubes of the plastic can be handled on automatic screw machines at speeds as high as 6,000 rpm. without a lubricant.

Laminated-molded rod and either molded or rolled quality tubing can be machined efficiently on automatic screw machines at speed as high as 6,000 rpm., and at high rates of feed. Diamond and tungsten carbide turning and boring tools can be used to advantage in these operations. Usually, lubricant will be unnecessary, but with some operations—threading, for example—flooding the work with lard oil and kerosene will prove helpful.

Milling operations on laminated phenolics are performed the same as on brass, and with standard cutting tools. High-speed steel cutters should run at a maximum of 400 ft. per min. Feed rate will depend entirely on the degree of finish desired. The work should be backed up with wood or any rigid material to guard against splitting. In designing a part, avoid stopping a milled slot with square corners. Allow the bottom of the slot to emerge to the surface with the natural contour of the cutter. "Climb" milling is recommended.

For turning and boring, good finishes are best attained with a round-nose tool. To get a polished finish of extra smoothness, cut with the heel of the tool with very little clearance, particularly when facing parallel with the laminations. When using high-speed steel, operate at a maximum of 600 ft. per min., although 1,500 ft. per min. can be attained with tungsten carbide. To prevent burrs where the boring tool comes through, always back up the material with wood or other rigid material.

Bright Annealing of Nickel Silver Accomplished on Production Basis

Scale-free, clean metal surfaces can be maintained during stress relief annealing by careful selection of atmosphere and furnace equipment.

by JOHN W. CARTER, Development Engineer, Surface Combustion Corp.

● THE STRESS RELIEF annealing of nickel silver is a critical operation in the processing of this important commercial alloy. It is particularly critical where a bright clean metal surface must be maintained. As is well known, nickel silver is a silver colored alloy containing 65 copper, 18 nickel, and 17% zinc. The alloy is difficult to bright anneal because of its zinc content. This element oxidizes during annealing even in atmospheres containing no free oxygen. As a further complication, zinc volatilizes in the hot zone and condenses on any cool surface in the furnace.

At International Silver Co., Meriden, Conn., producers of silver-plated tableware, radiant tube, gas-fired controlled atmosphere, continuous belt furnaces have proved to be a most effective means of carrying out the annealing process while maintaining the bright clean metal surface essential for silver-plated tableware blanks.

The various shaped blanks for tableware are punched from strips of nickel silver, and are rolled and stamped to form individual patterns. During these forming processes, cold working takes place which requires stress relief of the metal by annealing, usually in the temperature range of 1100 to 1500 F. The hardness of the individual blanks varies with the degree of the cold working to which the particular areas have been subjected, average values being from 80 to 90 Rockwell B. Annealing reduces the hardness to values from 30 to 40 Rockwell B.

In the subsequent stamping operations carefully-formed dies are employed. It is imperative that the annealed blanks be absolutely clean and scale-free to insure maximum die life. Pickling has been used to clean the blanks; however, a perfectly bright anneal is preferable since it eliminates the handling, fumes and maintenance costs of a pickling line.

Atmosphere for Annealing

Several atmospheres are available which will satisfactorily prevent the oxidation of nickel silver. Dehydrated, burned ammonia provides a very satisfactory atmosphere. However, in most locations it is extremely expensive because of the price of the ammonia used as the raw material. Rich DX gas, an atmosphere made from the dehydrated, sulfur-free products of the incomplete combustion of a fuel gas, has provided the International Silver Co. with a perfectly bright annealing atmosphere at approximately one-tenth the cost of an ammonia-base atmosphere. Perfectly bright anneal means that the metal charged into the annealing furnace emerges from the furnace after annealing and cooling as clean and bright as it was when charged.

It has been established in Surface Combustion's development laboratories that, under properly controlled conditions, a perfectly bright anneal of nickel silver can be obtained using dehydrated, sulfur-free rich DX gas. An approximate analysis of the atmosphere generated for the operation of two continuous mesh belt, bright annealing, radiant tube furnaces at International Silver is tabulated below. The gas used for combustion fuel as well as for generating the atmosphere gas was a manufactured gas having a heating value of 540 Btu per cu. ft.

CO_2	5.0%
O_2	0.0%
CO	9.0%
CH_4	0.2%
H_2	10.9%
N_2 et al	74.9%

In the hot zone of the furnace, the equilibrium conditions of the atmosphere shift, materially raising the dewpoint. This rise in dewpoint is due primarily to the water gas reaction:

$$CO + H_2O \leftrightarrows CO_2 + H_2$$

The water vapor thus formed is capable of oxidizing zinc either at the work surface or in the form of zinc vapor in the furnace atmosphere.

It is possible by controlling atmosphere flow to flush the hot zone continually with fresh, dehydrated atmosphere. The dewpoint in the hot zone is not too critical to bright annealing at 1300 to 1400 F. In the annealing furnaces at International Silver, the dewpoint is controlled by the rate of atmosphere flow. At the outlet of the hot zone going into the slow cooling zone, the dewpoint must be maintained at minimum values if zinc oxide is not to be formed on the work. This low dewpoint in the cooling zone is maintained by introducing the major portion of the atmosphere gas at the outlet of the hot zone. The discharge outlet of the furnace cooling zone, the cooling fans and exhaust hood dampers are set to maintain a positive effluent pressure of atmosphere gas at the charge end of the furnace. This arrangement has the advantage of carrying zinc vapors out the charge end rather than allowing them to contaminate the cooling zone atmosphere and deposit on the annealed work. It also provides a non-oxidizing atmosphere for the cooling zone of the furnace. The annealed nickel silver is thus protected and emerges from the furnace bright and clean.

Annealing Time and Temperature

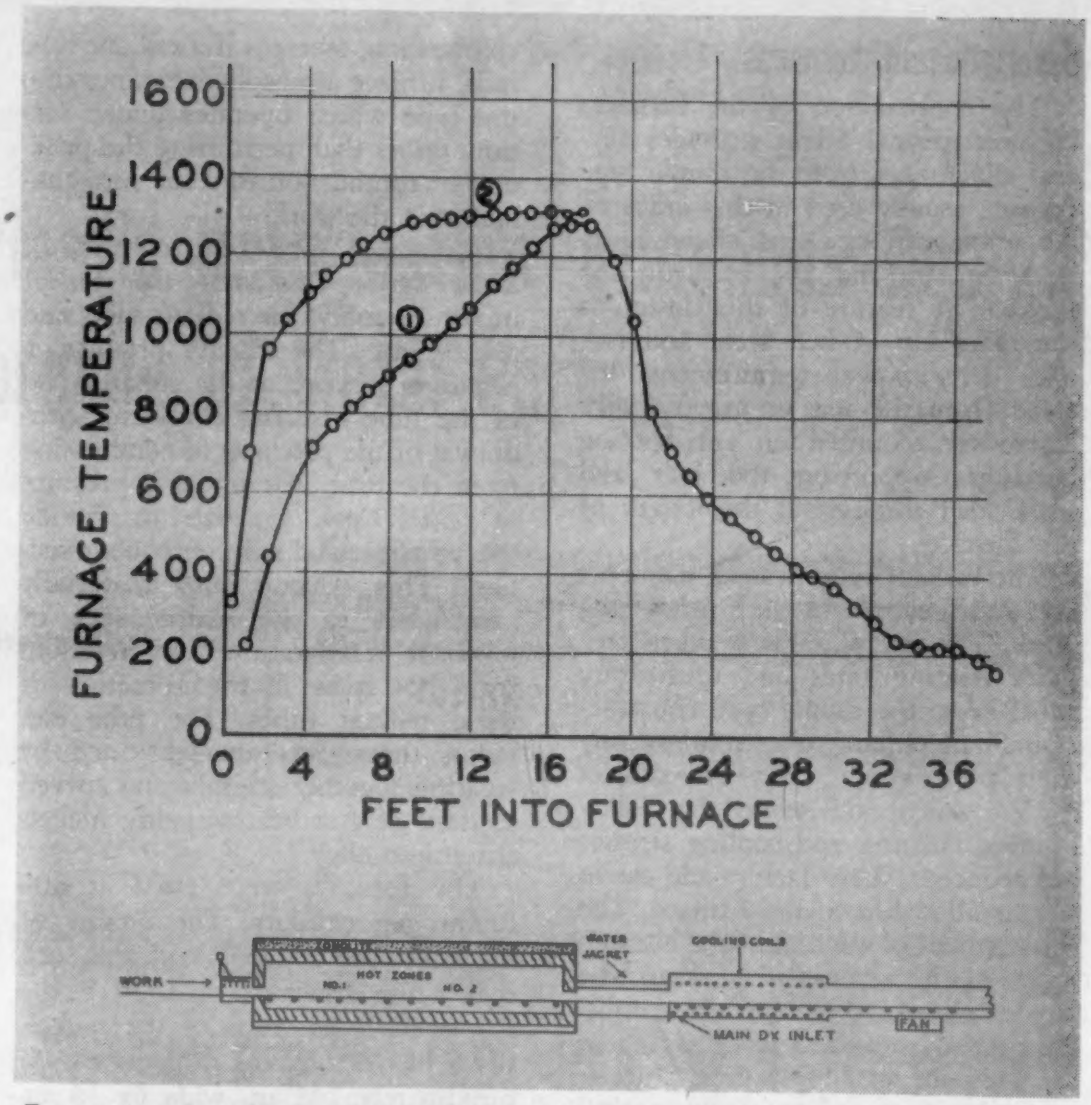
To inhibit the formation of zinc vapor, annealing time should be as brief as possible. Long soak periods at annealing temperatures of 1300 to 1400 F succeed not only in producing

grain growth but also in reducing the total zinc content of the alloy through zinc volatilization. Thus, time is a critical factor in the bright annealing of nickel silver. When this alloy is held at 1400 F for more than 30 min., it acquires an etched appearance; continued holding at this temperature produces an undesirable change in metal color. These phenomena make it impossible to effect a perfectly bright anneal if annealing time is extensive.

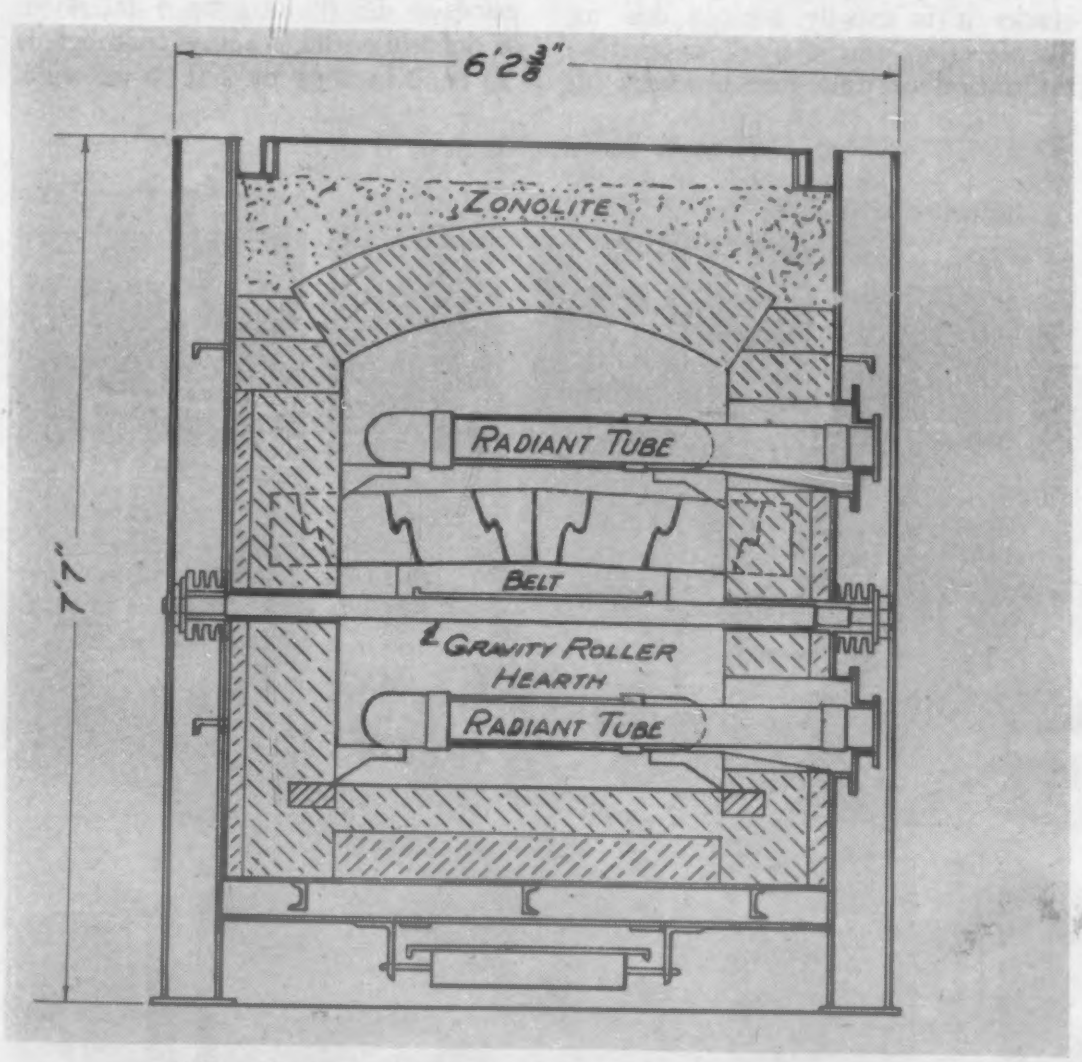
It has been found in experimental studies that a staining is prone to take place on nickel silver annealed in the lower portion of the previously cited 1100 to 1500 F range, even in dehydrated rich DX atmosphere. This staining effect is observed when the alloy is slowly cooled after annealing in the higher portion of this temperature range. It reaches a maximum at some critical temperature in the lower end of the annealing range.

Two factors influence staining in this critical temperature region: water vapor content of the DX atmosphere, and the rate of cooling through this temperature region. As previously mentioned, the water gas reaction of dehydrated rich DX gas at 1300 to 1400 F results in a dewpoint that is usually close to the ambient temperature. Cooling in a DX atmosphere of this dewpoint range would have to be very fast, equivalent to a liquid quench, to produce bright nickel silver. However, when the dewpoint of the dehydrated DX atmosphere is kept extremely low in the cooling zone, bright work is produced with relatively slow cooling rates.

For best bright annealing results, the volatilization of zinc in the nickel silver should be held to a minimum. The accompanying curves show results of thermocouple surveys illustrating different heat curves possible for annealing operations, resulting in satisfactory Rockwell B hardness values. On curve No. 1 the work is held at the high temperature for a shorter time; consequently, there is less chance for any change to take place in the analysis of the alloy through the escape of zinc as vapor. Not all of the zinc vapor is carried out of the furnace by the effluent atmosphere; much of it deposits on curtains and cool surfaces both as zinc and zinc oxide, the latter forming due to the high dewpoint in the hot zones. A powdery crust is built up on these surfaces and is removed periodically; otherwise, it would crumble off and fall onto the work, causing discoloration.



Temperatures in various parts of bright annealing furnace for two different annealing cycles. Cycle shown by curve 1 will produce minimum zinc volatilization.



Schematic drawing of section through hot zone of one furnace.

Description of Furnaces

The construction of the furnaces at International Silver provides several advantages over the muffle type furnace usually used in this industry. An accompanying sketch shows a section through the hot zone of one furnace. A feature of this design is the reduction of belt wear and furnace drive power requirements derived from the use of gravity rolls. These are mounted on anti-friction bearings supporting the belt and work load throughout the length of the furnace.

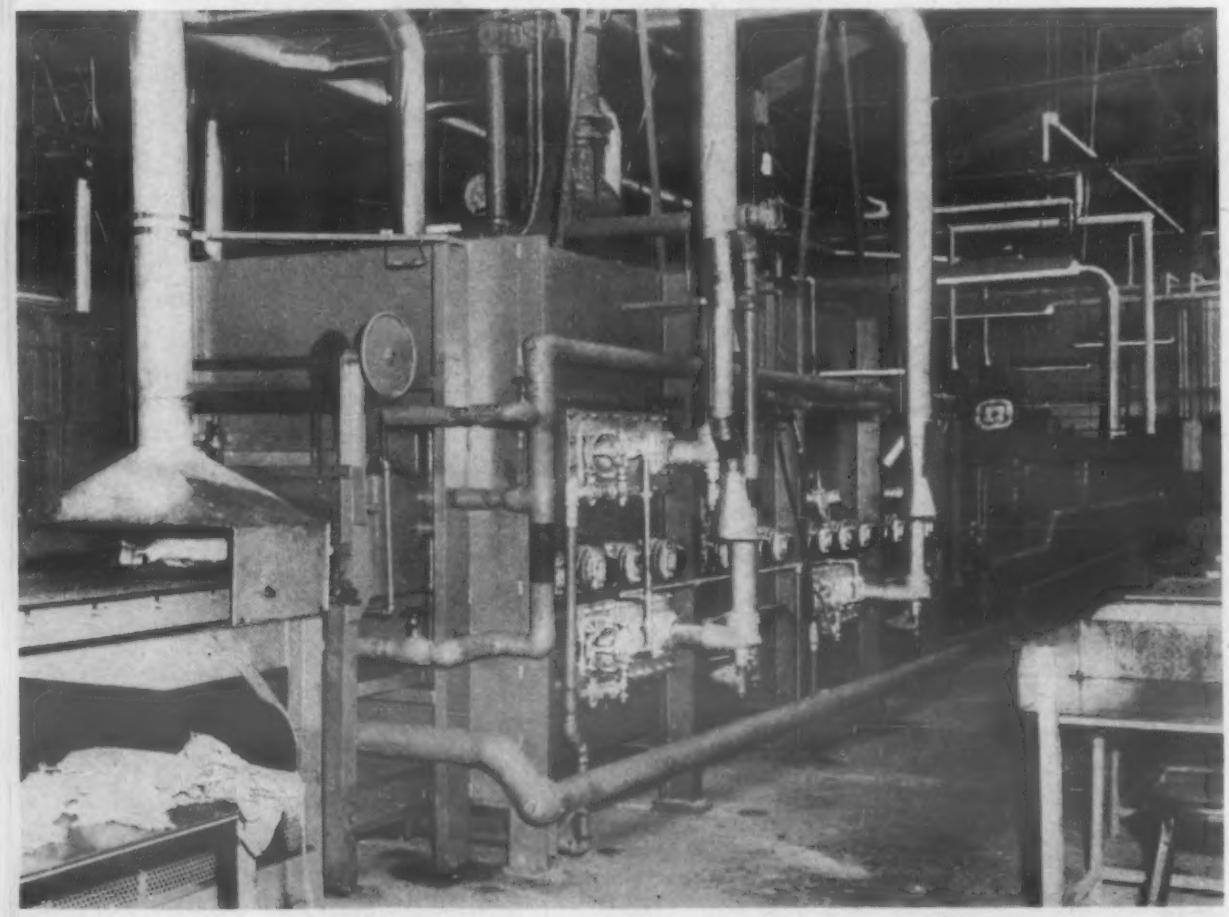
The radiant tube heating elements are arranged above and below the work. The use of radiant tubes provides heating rates and uniformity superior to the muffle type construction. Since radiant tubes support only their own weight, they are subject to less stress and strain than alloy muffles. Heating and cooling stresses are reduced. These factors add up to longer alloy life in the furnace. The replacement of a radiant tube is much more easily accomplished than the replacement of a furnace muffle. This means time and labor saving in the event of an alloy failure, since it is much easier and more economical to replace an individual radiant tube than to repair or replace a large muffle. Furthermore, when a muffle cracks it is usually noticed due to discoloration of the work caused by infiltration of untreated products of combustion, whereas if a radiant tube fails, furnace atmosphere escapes into the tube which operates under suction, rather than permitting the products of combustion to come into contact with the work.

A radiant tube unit consists of three major elements: the gas-air mixer assembly, the radiant tube, and the eductor. The eductor produces a negative pressure at the exhaust end of the tube insuring complete withdrawal of the products of combustion from the tube. Air under a pressure of 1 to 1.5 psi. is utilized to provide the jet effect and the consequent suction. This eductor also materially contributes to the maintenance of uniform temperature and freedom from hot spots in the operation of these radiant tubes. The tube elements themselves are fabricated by welding together straight and curved sections of cast heat resisting nickel-chromium alloy.

The furnaces were rated at 800 lb./hr. net capacity. The quality of the annealing at rated load was such that when annealed at 1350 F the Rockwell B hardness of the nickel-silver blanks (having dimensions approximately 1¾ in. wide by ⅛ in. thick by 6½ in. long) varied only ±2 points across the hearth.

The heating chamber of the furnaces is 15 ft. long by 3 ft., 4 in. wide while the cooling chamber is 35 ft., 3 in. long by 2 ft., 6 in. wide.

Overall view of annealing furnace.



The conveyor belt is mesh woven of heavy gauge, 25 chromium-12 nickel alloy wire. The belt has ½ in. turned up on each edge to retain the work. Furnace entrance and exit openings are approximately 3 in. high. The furnace casing is of steel plates and structural shapes. Maximum thermal efficiency is attained through the extensive use of insulating firebrick and insulation.

Work is loaded onto the conveyor belt by hand, and also removed by hand. Blanks are stacked on edge inclined at 45 deg. to horizontal with their longitudinal axes parallel to that of the furnace. Furnace temperature is controlled in two zones. The charge end zone has "Off-On" control while the soak zone is on proportioning control with temperature drop correction. The latter provides accurate temperature control, which insures uniform grain size with anneal. The belt drive is equipped with a speed control transmission and tachometer calibrated in in. per min. to indicate belt speed.

Each of the furnaces is supplied by an individual DX atmosphere generator. An indexed orifice meter controls the gas mixture flowing to each generator combustion chamber. The atmosphere then flows into an indirect cooler, which removes most of the heat of combustion. Next, the atmosphere passes through washing and cooling towers. Beyond the towers, the atmosphere passes through an iron oxide tower which removes H_2S, thence to the dryers where the dewpoint is lowered by adsorption to a value that will insure the prevention of oxidation in the cooling zone of the furnace.

Orsat analysis provides the most accurate method of setting up and controlling atmosphere mixture. Variations in the specific gravity of the manufactured fuel gas can cause variations in the richness of the generated atmosphere. If the atmosphere is too rich, the edges of the work will begin to show discoloration due to carbon; on the other hand, if the atmosphere is too lean, the work will show a white zinc oxide blush. Operators quickly acquire skill in recognizing atmosphere deficiencies and are able to make any minor adjustments of the indexed mixture control meter necessary to maintain production of bright nickel silver. Under conditions thus controlled the bright annealing of nickel silver tableware blanks with rich DX atmospheres is currently being accomplished on a production basis.

Part 2- Plastic Flow and Rupture of Metals

How Plastic Deformation Influences Design and Forming of Metal Parts

by JOHN R. LOW, JR., Research Lab., General Electric Co.

This is the conclusion of a two-part article explaining simply and clearly how plastic flow data can be used to advantage in the design and production of metal products.

• IN ORDER TO intelligently use and work with metals, it is important for the engineer to have some knowledge about their fundamental mechanical behavior. In the previous article (Nov. 1949) the value of using true stress-strain data in design and metal forming was discussed, as well as the influence of a number of variables on the beginning of plastic flow. For a complete knowledge of how a metal behaves we must also know how plastic flow proceeds and under what conditions it ends in rupture. Therefore, in this article we will be concerned with the influence of metallurgical variables, and of external variables such as temperature, strain rate and combined stresses on flow and rupture.

As has already been pointed out, the plastic deformation of metals is best described in term of the *true stress-strain* curve or *flow curve.* The characteristic form of the flow curve in simple tension for most metals is that shown in Fig. 1. Except for the irregularities associated with the yield-point in steels, the typical curve relating stress and strain in the plastic region has a very high initial slope, which gradually decreases as straining proceeds and finally becomes constant at a point corresponding roughly to the maximum load in the test. The slope then remains constant until rupture occurs. At one time considerable significance was attached to this straight line portion of the flow curve, but it is now felt that this straight line portion, which represents the *average* stress-*average* strain relationship during necking is peculiar to the testing method and the necking phenomenon.

If we disregard the portion of the curve beyond the point at which necking begins we then find that for most metals a simple parabolic relationship exists between the true stress and the plastic strain. The analytical expression for the flow curve is:

$$S = K \times R^n$$

or

$$\log S = \log K + n \log R$$

where: S = true stress; R = true strain; and K and n are constants characteristic of the material.

The constants K and n may be regarded as the fundamental plastic flow constants of the material. The simple parabolic relationship between true stress and true strain is shown by the curves of several materials, Fig. 2. The points are experimental,

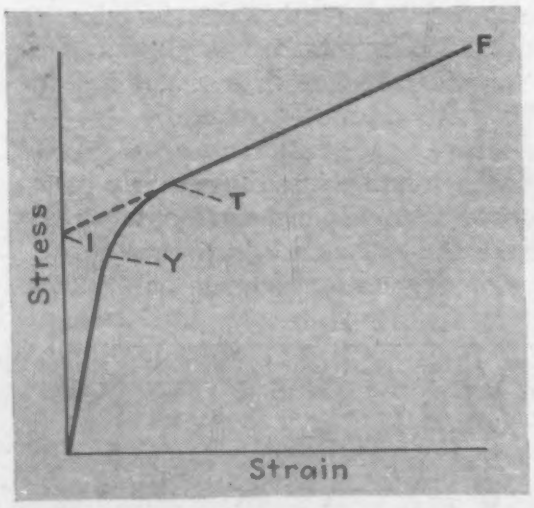


Fig. 1—Schematic flow curve showing how plastic flow proceeds to rupture. (Holloman)

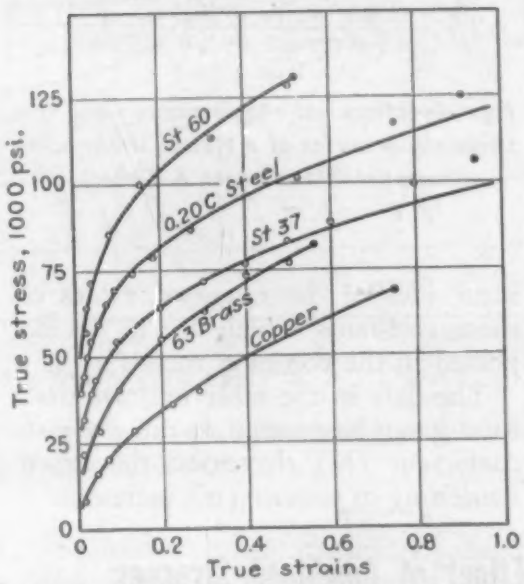


Fig. 2—Computed curves of several materials showing simple parabolic relationship between true stress and true strain. Points are experimental.

and the curves are computed from the equation with appropriate K and n values. If we plot the logarithm of the stress vs. the logarithm of the strain we obtain a straight line. Fig. 3 shows the logarithmic stress-strain curve for a temper-rolled, low carbon, fully aluminum killed deep drawing sheet steel between initial yielding and the maximum load in the tensile test.

The validity of the parabolic relationship between stress and strain cannot be considered to have been verified for all metals as yet, but in general it is at least a sufficiently good approximation to be very useful. The accompanying table lists the K and n values which have been determined for a number of metals, and gives

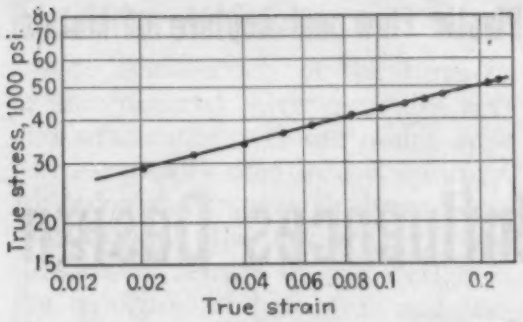


Fig. 3—Logarithmic stress-strain curve for temper rolled, 0.05% C, aluminum killed deep drawing sheet steel from yielding to beginning of necking.

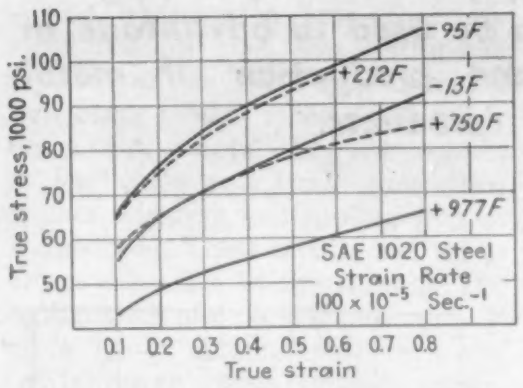


Fig. 4—Effect of temperature on true stress-strain curves of a typical strain-aging material. (MacGregor & Fisher)

some idea of the range of values of these constants which are to be expected in the common metals.

The data in the table indicate that, for a given base metal, as the *strength coefficient* (K) decreases, the *strain hardening exponent* (n) increases.

Effect of Combined Stresses

Thus far we have been discussing the flow curve of a metal for a single stress system—that of the simple tension test. If the flow curve thus determined had no other significance we would hardly be justified in devoting so much time to the determination and analysis of simple tension flow curves. We now have, however, considerable evidence that the relationship between stress and strain for plastic flow can be generalized for all states of stress in much the same way that the condition for initial yielding is generalized by the shear-strain-energy theory. If this generalization is valid, then, just as in the case of initial yielding, we need only determine the behavior in simple tension to be able to predict the behavior for any combination of stresses.

In discussing flow under combined stresses we require a particular function of the three principal stresses and a particular function of the three principal strains which will always have the same relation to each other regardless of the state of stress under which flow takes place. If the particular stress and strain functions which fulfill this requirement can be determined, then we may use a single flow curve of this stress function vs. this strain function to describe the plastic behavior of a metal for any combination of applied loads. The stress and strain functions which have been found to be most nearly in accord with experimental observations are the so-called *effective stress* and *effective strain* defined as follows:

$$\text{Effective stress} = \sqrt{\frac{(S_1-S_2)^2+(S_2-S_3)^2+(S_3-S_1)^2}{2}} = \bar{S}$$

$$\text{Effective strain} = \sqrt{\frac{2\,(R^2_1+R^2_2+R^2_3)}{3}} = \bar{R}$$

S_1, S_2, S_3 are the principal stresses
R_1, R_2, R_3 are the principal strains, *i.e.*, the true strains in the direction of the three principal stresses.

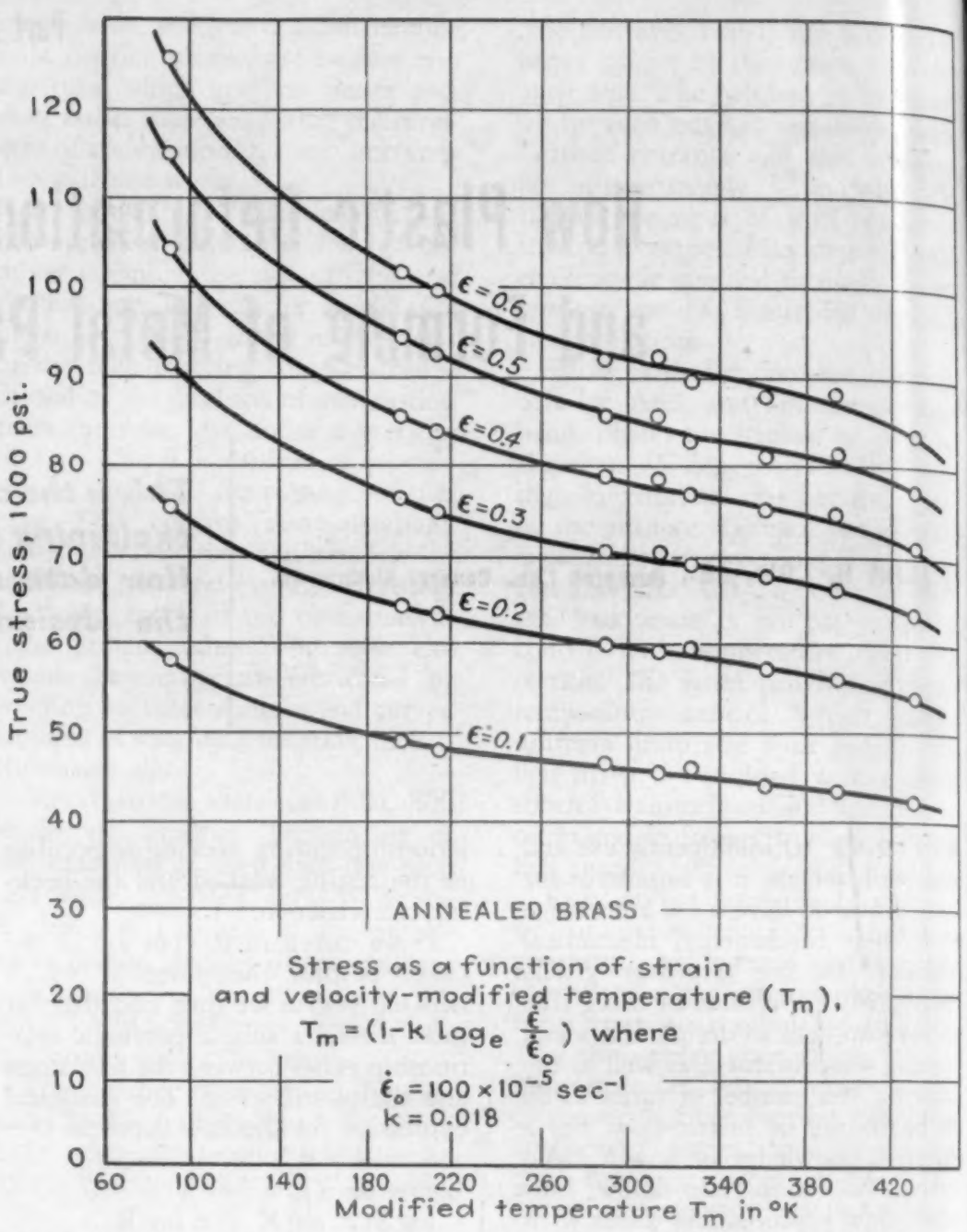


Fig. 5—Stresses as a function of strain and temperature for leaded brass. (MacGregor & Fisher)

The importance of these formulas lies in the fact that if we determine the effective stress vs. effective strain curve for a given metal for a particular stress combination, we have determined the relationship between all three principal stresses and all three principal strains for any stress combination. For example, the stress combination for the simple tension test is $S_1 = S$; $S_2 = S_3 = O$ and $\bar{S} = S_1$, the true stress of the simple tension flow curve. Furthermore, since there is no volume change during plastic flow in metals $(R_1 + R_2 + R_3)$ will always equal zero. Combining this relation with the expression for the effective strain above, we find that for the simple tension test $\bar{R} = R_1$. Thus, the true stress-strain curve of a metal in simple tension is also the effective stress-effective strain curve for the metal, and we can use the simple tension test to

Fundamental Plastic Flow Constants for a Number of Metals

(Room Temperature Tests)

Material	Condition	K (psi.)	n
0.40% C Steel	Quenched and tempered at 400 F	416,000	0.088
0.59% C Steel	Quenched and tempered at 1000 F	228,000	0.097
0.59% C Steel	Quenched and tempered at 1100 F	206,000	0.110
0.59% C Steel	Quenched and tempered at 1200 F	184,000	0.150
0.59% C Steel	Quenched and tempered at 1300 F	178,000	0.190
0.05% C Steel Sheet	Annealed and temper rolled	72,000	0.235
24S Aluminum Alloy	Precipitation hardened	100,000	0.16
24S Aluminum Alloy	Annealed	49,000	0.21
Copper	Annealed	46,400	0.54
70-30 Brass	Annealed	130,000	0.49

establish the relationship between stresses and plastic strains for any system of combined loads.

Our ability to determine the effective stress-strain curve for all states of stress by means of a simple tension test greatly simplifies the study of the influence of other variables such as temperature, rate of deformation, composition, and heat treatment on the plastic flow characteristics of a material. We can now use the simple tension test to study these effects and expect, with reasonable certainty, that our observations will be useful in predicting behavior under other loading conditions such as those encountered in various types of forming operations.

Effect of Temperature and Strain Rate

The effect of a variation in temperature on the flow curve of a metal is similar to the effect on the yield stress which we have already discussed. In general, the whole of the flow curve is raised by a decrease in temperature and lowered by an increase in temperature, except in those cases when strain-aging occurs. In Fig. 4 are shown some of the data of MacGregor and Fisher for a strain-aging steel (SAE 1020). As the temperature is raised above —95 F, the stress to produce a given strain decreases, except in the strain-aging range of temperatures, for this speed of testing. In this range the strain-aging, which occurs simultaneously with the deformation, raises the curve (curves 212 F and 750 F). What might be considered the "normal" effect of temperature is illustrated in Fig. 5, where similar curves are shown for a leaded brass.

As in the case of the yield stress, the effect of an increase in the rate of deformation is to raise the whole stress level of the flow curve. The magnitude of this effect is not very great for steel at room temperature and below but is very marked at elevated temperatures. The influence of the rate of deformation on the true-stress-strain relations for mild steel can be seen in Fig. 6. The comparison between the effect of strain rate at room temperature and at 1110 F should be based upon some strain greater than the yield-point elongation, *e.g.*, the 12% strain curves in Fig. 6. The curves of stress at low strain values and at room temperature exhibit an abnormal effect of increasing strain rate due to the fact that the yield-point in steel is much more sensitive to changes in strain rate than in the balance of the flow curve or the yield-stress in other metals. This same abnormal effect is not observed at 1110 F, since at this temperature the yield-point is no longer observed. It should be noted that the *logarithm* of the strain rate is plotted against stress to produce a given strain—in other words, a relatively large change in strain rate is required to bring about any substantial change in the flow curve.

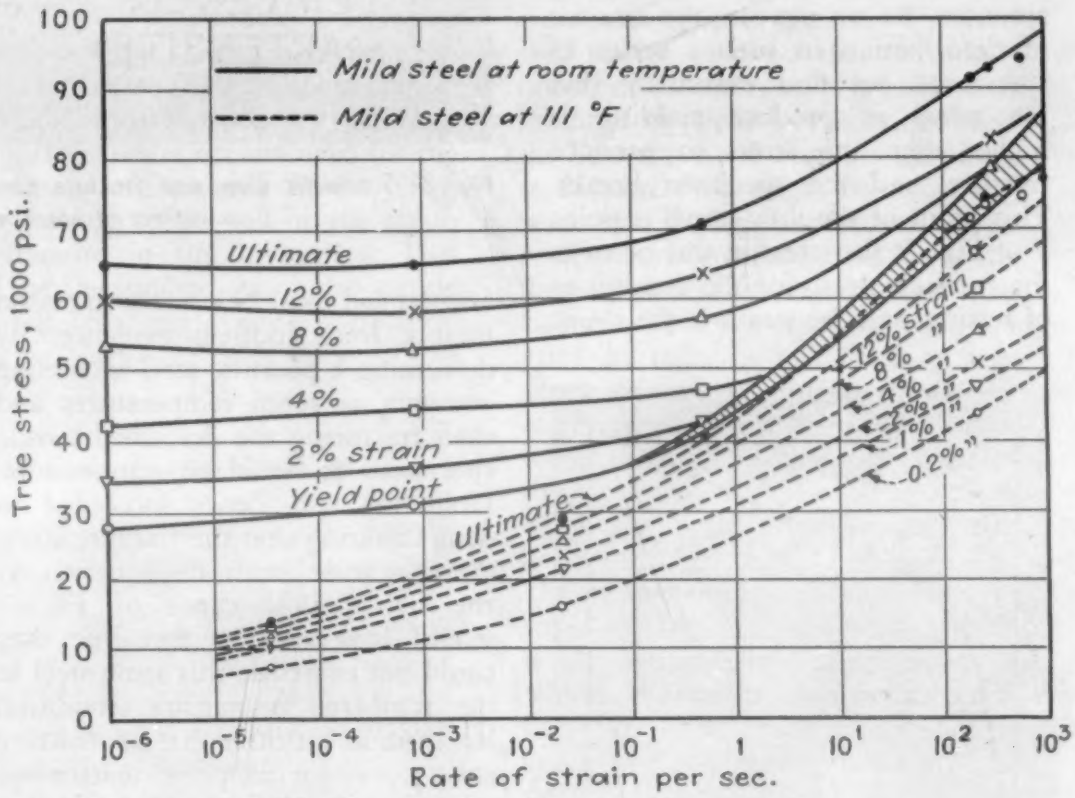


Fig. 6—True stresses at various strains versus strain rate for mild steel at room and elevated temperatures. (MacGregor & Fisher)

Without going into the quantitative equivalence between the effect of strain-rate and temperature on the flow curve, we should mention that a slight change in temperature is equivalent in its effect on the flow curve to a very large change in strain-rate. For example, for steel in the vicinity of room temperature, a decrease of 110 F in the testing temperature is approximately equivalent to a 1000-fold increase in the rate of straining.

The Fracture Strength of Metals and Ductility

Up to this point we have confined our attention to the flow curve without specific mention of the conditions which lead to the end of plastic flow, which is rupture. The flow curve may be considered to be the locus of points representing the stress re-

quired to produce plastic flow in a metal. When a metal is deformed, it strain-hardens and if we are to cause plastic flow of this strain-hardened metal we must apply a higher stress than was originally required before any plastic flow occurred. Thus, if we strain a specimen 10% and remove the load, we find that upon reloading the yield-stress is greater than it was in the undeformed condition. The flow curve may be thought of as representing the yield stresses of a continuous series of specimens which have been deformed increasing amounts. As we increase the amount of deformation in such a series of specimens, we find eventually that the stress to produce yielding is higher than the stress to produce fracture, and the specimen breaks. This point of the flow curve is point F of Fig. 7; the stress at this point is the *fracture stress* for the conditions of testing, and the strain is the *strain*

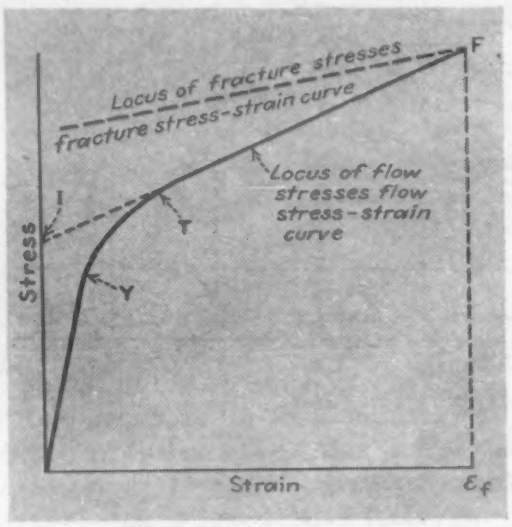


Fig. 7—Schematic flow and fracture stress-strain curves.

to *fracture*. For any strain less than this strain the fracture stress is greater than the stress to produce flow and the metal deforms instead of rupturing. We may therefore, as in Fig. 7, draw a hypothetical fracture stress curve which lies above the flow curve. For the complete description of the mechanical behavior of a metal we must determine not only the flow curve and how it is influenced by external variables, but also the fracture stress curve and how it is influenced by these same variables.

In the section dealing with the flow curve we were able to present quantitative data on the flow curves of a number of metals and describe the influence of combined stresses, temperature and strain rate on these flow curves. We cannot at present describe the fracture curves for metals in anything like as quantitative a

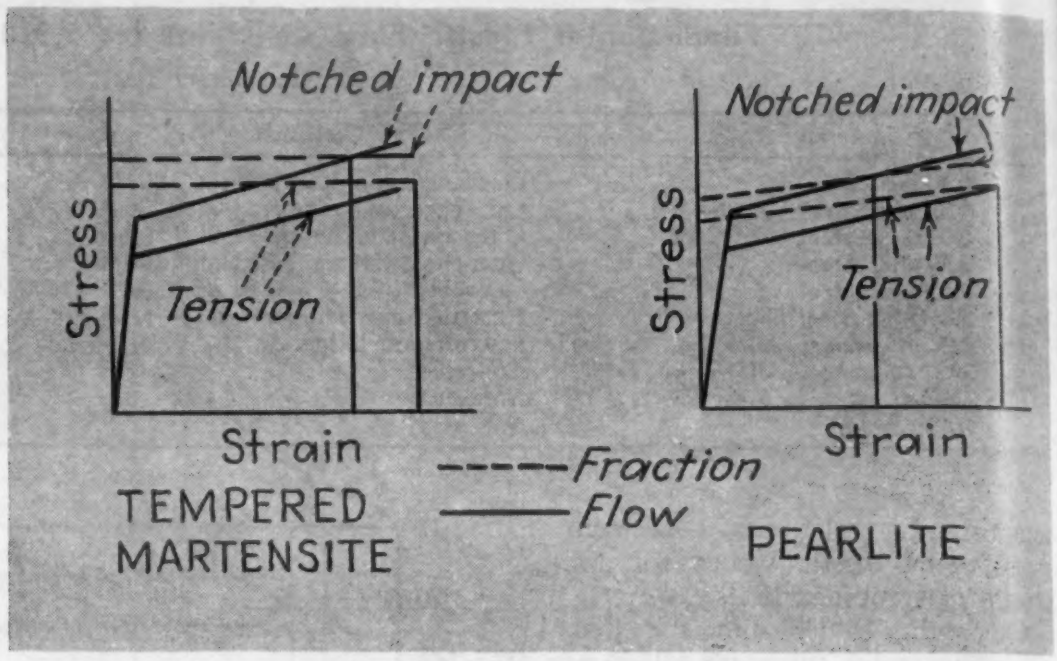


Fig. 8—Schematic flow and fracture curves of pearlitic and martensite steels showing effect of notch and impact. (Hollomon)

fashion and must be content to reason mainly from indirect evidence. By deforming a pearlitic steel increasing amounts at room temperatures and then fracturing the deformed tensile specimens at liquid air temperature, Hollomon and Zener succeeded in demonstrating that the fracture stress does increase with deformation as the hypothetical curve of Fig. 7 would indicate. The fact that they could not embrittle this same steel in the tempered martensitic condition led them to conclude that the fracture stress curve for tempered martensitic structures must lie well above that for pearlitic structures even when both structures have the same flow curve.

The strain at the point at which the flow curve and the fracture curve intersect is the strain to fracture, *i.e.*, the ductility under the particular conditions of testing. If we change the conditions so that the flow curve shifts relative to the fracture stress curve, we will change the strain to fracture. If, for example, the flow curve is raised by combined stresses, increasing strain-rate or decreasing temperature, as a faster rate than the fracture stress curve is raised by these same changes, we may expect the two curves to intersect at a lower value of the strain—*i.e.*, the metal will become less ductile. On the other hand, if we can raise the fracture stress curve with respect to the flow curve by a change in structure, for example, we can expect that much more severe conditions of stress combination, temperature or strain rate will have to be imposed before the ductility is decreased an equivalent amount.

These ideas can be used to explain qualitatively the difference in behavior in the impact test between pearlitic and martensitic steels, as shown in Fig. 8. It is assumed that the flow curves are identical in both steels but that their fracture stress curves differ, that for the martensitic steel lying higher than that for the pearlitic steel. The effect of the combined stress introduced by the notch and the increase in speed of deformation due to the impact loading is to raise both the flow and fracture curves, but to raise the former more. The result is a loss in ductility indicated by the shift in the point of intersection of the flow and fracture stress curves to a lower strain value. This shift is greatest in the case of the pearlitic steel because the separation of the two curves was initially less in this case.

Because of the experimental difficulties involved, very little quantitative information is available concerning the influence of external variables on the fracture stress curves for various metals. Scattered observations do indicate that the fracture stress is affected qualitatively in the same manner as the flow stress by combined stresses and temperature; that is:

1. The fracture stress at a given strain increases with decreasing temperature.
2. The fracture stress at a given strain is increased by combined stresses.

The effect of strain rate on fracture stress is as yet undetermined.

Practical Applications of Principles

In present-day aircraft construction, riveting is probably the most

common method of joining. On the outer surface of an airplane it is customary to use so-called "flush-riveting" to obtain the smoothest possible surface and thus reduce aerodynamic drag. There are two methods of flush riveting. In the countersink method it is necessary to machine each rivet hole; in the second and more commonly used "dimpling" method, countersinking to accommodate the rivet head is accomplished by plastically deforming the metal in the vicinity of the rivet hole to the proper shape. The sequence of operations for dimpling is shown in Fig. 9. In addition to the bending that is involved, the diameter of the hole punched in the flat sheet is also expanded. The circumferential strain at the inner surface of the hole required to make a properly shaped dimple is quite high and may exceed the strain to fracture for the material. In this case radial cracks develop during dimpling and the sheet must be scrapped.

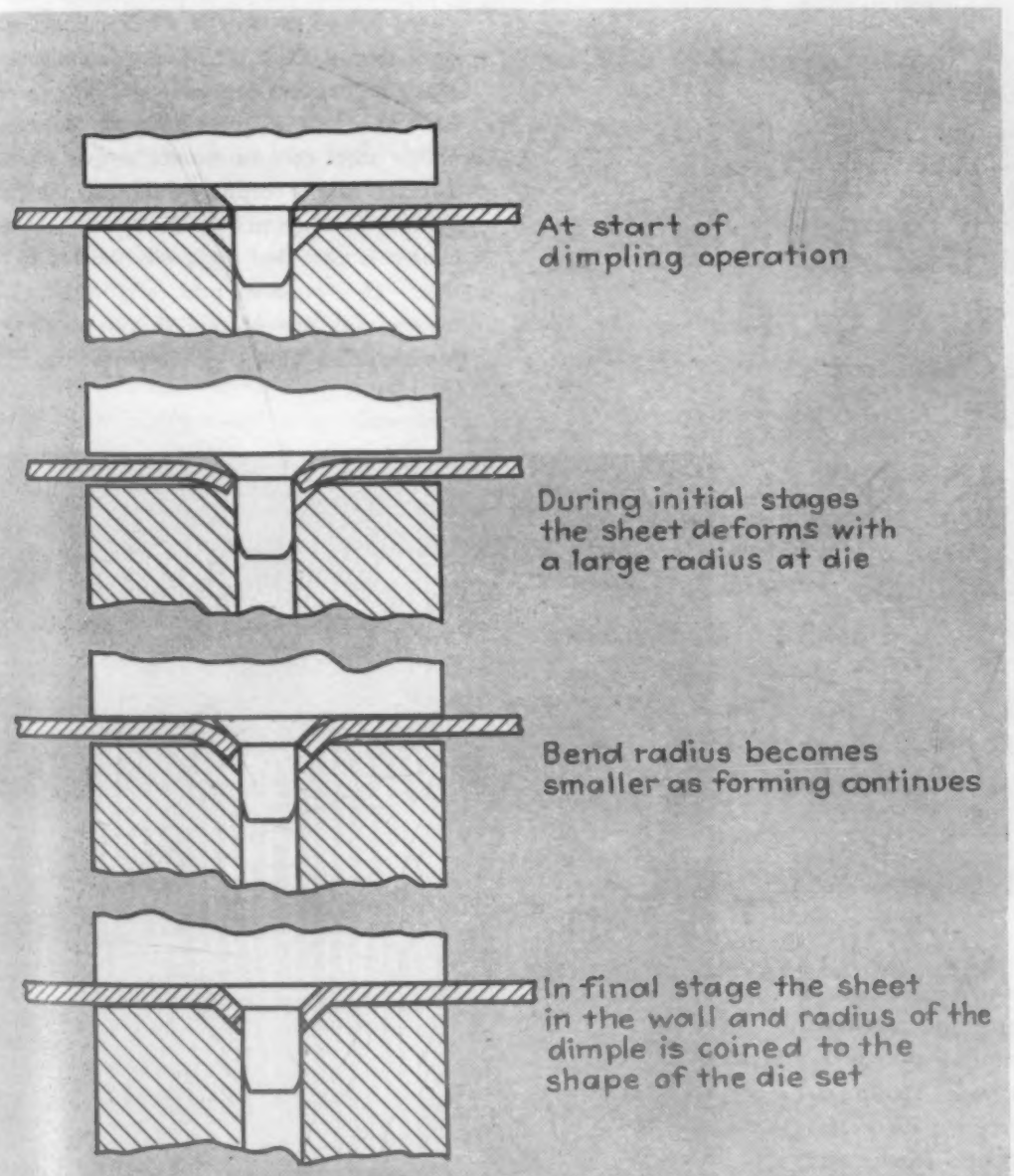
A deficiency in ductility in the dimpling operation proved a serious handicap to the use of some of the higher strength aluminum alloys for aircraft construction during the war, and the abandonment of these alloys was contemplated. Fortunately, two methods were found for improving the ductility in this operation which permitted the use of these otherwise very desirable alloys.

Analysis of the mechanics of deformation in the dimpling operation indicates that the state of stress at the circumference of the rivet hole is essentially one of simple tension. Cracks develop, therefore, because the sheet is deficient in ductility in simple tension. Since the necking phenomenon is generally not involved for the conditions encountered in dimpling, the limiting strain will be the strain to fracture in simple tension. This can be determined from the simple tension test, and a close correlation can be shown to exist between the true strain at fracture in simple tension and the limiting circumferential strain at the edge of the rivet hole in dimpling. The problem thus becomes one of changing the external variables (rate of deformation, temperature or stress combination) to increase the strain to fracture since we cannot change the metal without affecting the very desirable strength properties of the alloy.

If we can so change the stress combination that the flow stress curve is lowered relative to the fracture stress curve, we could expect to increase the strain to fracture. We have seen earlier (Fig. 8) that the application of *lateral tensile stresses* such as those developed in a notch raise the flow curve and *decrease* the strain to fracture. We might therefore expect that the application of *lateral compressive stresses* would lower the flow curve and *increase* the strain to fracture. This principle has been applied in reducing the cracking tendency during dimpling by so designing the tools that the edge of the hole to be expanded is under pressure in the thickness direction of the sheet while the periphery of the hole is being stretched.

A second method of increasing the strain to fracture in simple tension is to increase the temperature at which deformation occurs. Except in these materials which exhibit strain-aging we can expect a continuous decrease in the height of the flow curve and a continuous *increase* in the strain to fracture as the temperature is raised. This principle has been applied in the successful "hot-dimpling" process in which the edge of the rivet hole is warmed by the passage of an electric current (resistance heating) or by contact with heated tools just before the dimple is formed. Hot dimpling machines which carry out automatically the complete process of punching, heating and dimpling have greatly reduced the hazard of breakage in this difficult forming operation.

Fig. 9—Action of dies and change in sheet profile during dimpling. (Finch & Dorn)


At start of dimpling operation
During initial stages the sheet deforms with a large radius at die
Bend radius becomes smaller as forming continues
In final stage the sheet in the wall and radius of the dimple is coined to the shape of the die set

CORRECTION

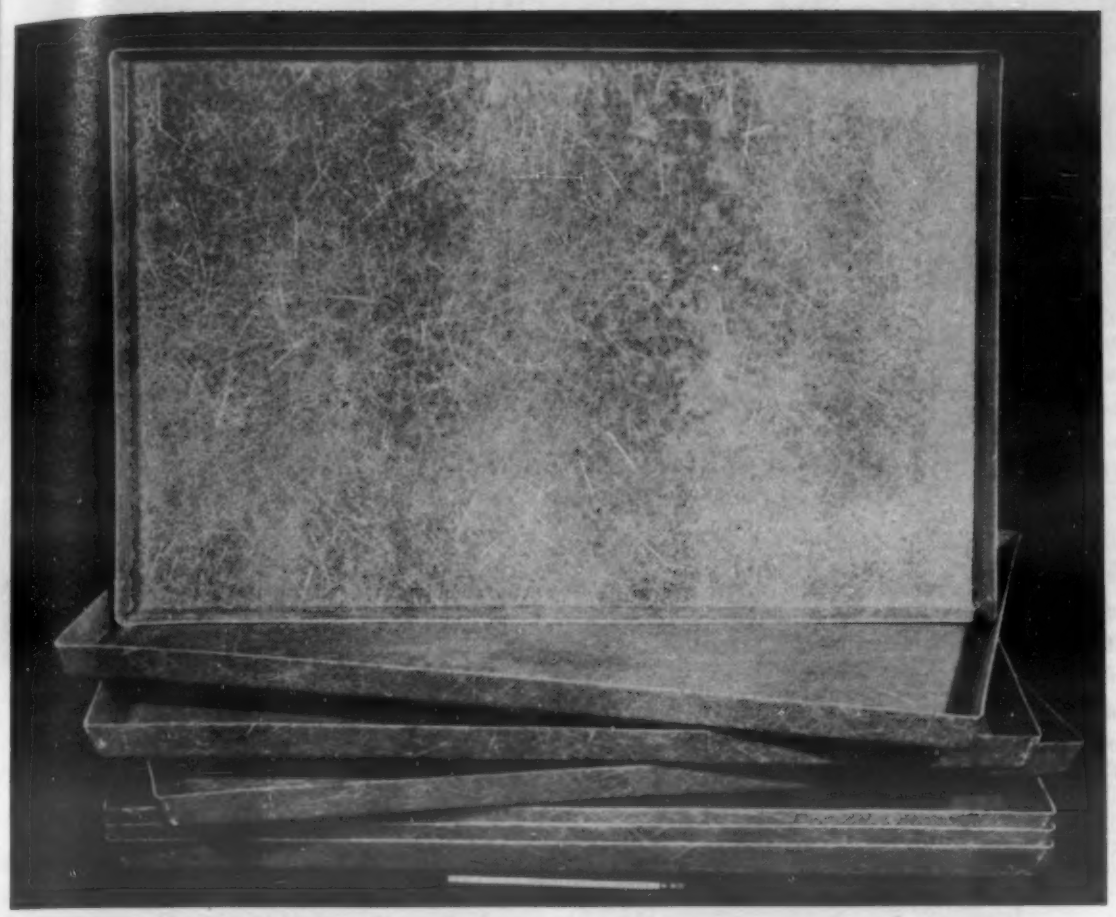
In Part 1 of this article, which appeared in November, the following two corrections should be noted on page 51: In 1st column, 13 lines from bottom, the expression "S_1 and S_2 and $S_3 = 0$" should read "$S_1 = S_2$ and $S_3 = 0$." In 2nd column, 14 lines from top, the expression "$(\frac{1}{2}\ S_1)$" should read "$(\frac{1}{2}\ S_0)$."

Materials at Work

Here is materials engineering in action . . .
New materials in their intended uses . . .
Older, basic materials in new applications . . .

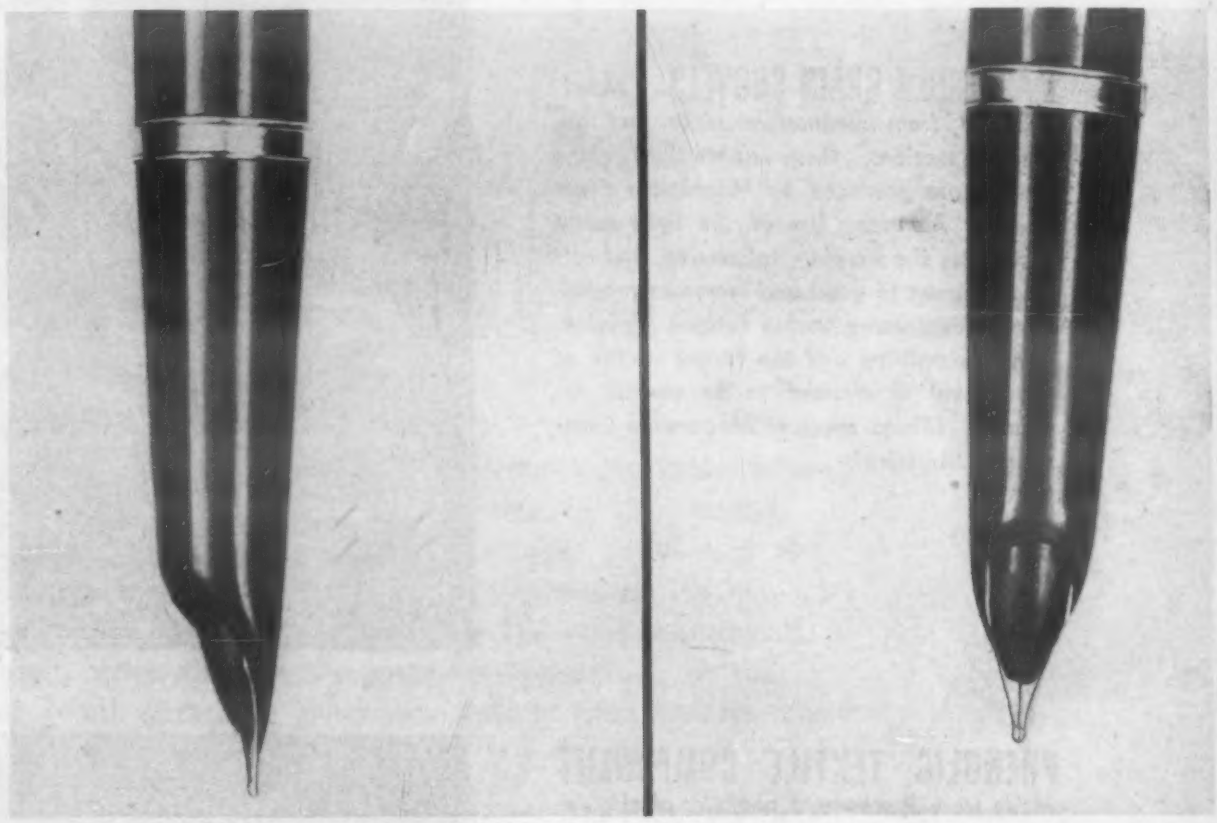
PLASTIC AIR PRE-CLEANER *Designed to help pre-clean air before intake to tractor carburetors, this clear plastic jar, produced by the Lakone Co., is attached to the standard metal air cleaner by a metal clamp ring. The cellulose acetate butyrate Tenite jar catches the heaviest particles of dust and dirt before the air enters the cleaner, and can be easily removed for emptying. Plastic was chosen for this application because it offers transparent clarity combined with resistance to shattering and because it withstands the extremes of temperature under which tractors have to work.*

ALUMINUM RADIATOR *Developed to cool the transmitting tubes used in radio broadcasting, this aluminum radiator is produced by the Al-Fin Div. of Fairchild Engine & Airplane Corp. Utilizing aluminum in place of copper, the new unit weighs only half as much as conventional coolers. A hollow steel core surrounds, and is soldered directly to the copper anode of the tube. To this core a thick layer, or muff, of aluminum is cast and integrally bonded to the steel. One hundred and forty vertical aluminum fins are brazed to this muff in a fan shape as shown.*



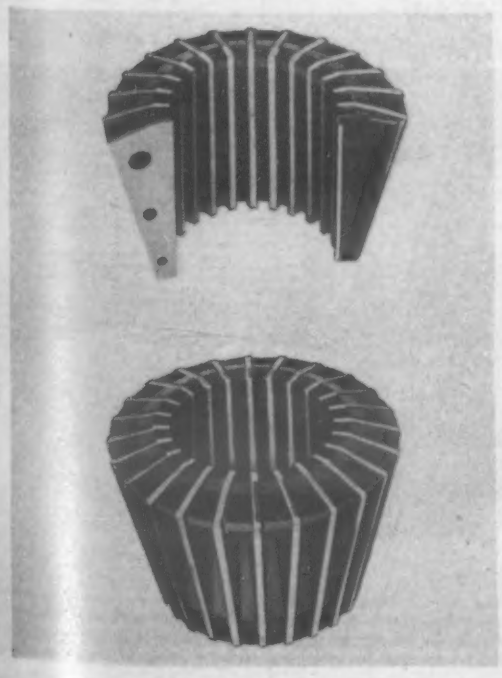
PLASTIC PHARMACEUTICAL TRAYS

Low-cost drying trays and pans are supplanting vitreous-coated metal units in the chemical and pharmaceutical industries. The trays are made of Glastic, a glass fiber reinforced polyester resin, by Laminated Plastics, Inc. The trays are light in weight, durable, and resistant to denting and chipping. They resist temperatures up to 350 F and the effects of most solvents, hydrocarbons, acids, alkalies and salts. Colors can be incorporated into the trays if desired for identification of the contents being handled.



ALLOY PEN NIBS

An eight-metal alloy composed of cobalt, nickel, chromium, molybdenum, manganese, iron, beryllium and carbon known as Octanium is currently in use by the Parker Pen Co. for the nib or point of fountain pens. Its extremely high tensile strength of 368,000 psi., its non-corrosive, non-magnetic qualities, and its lack of susceptibility to changes in crystalline makeup under varying temperature conditions offer advantages over conventional materials for this use. The alloy offers a very soft and pliable writing quality when used in the pen nibs.



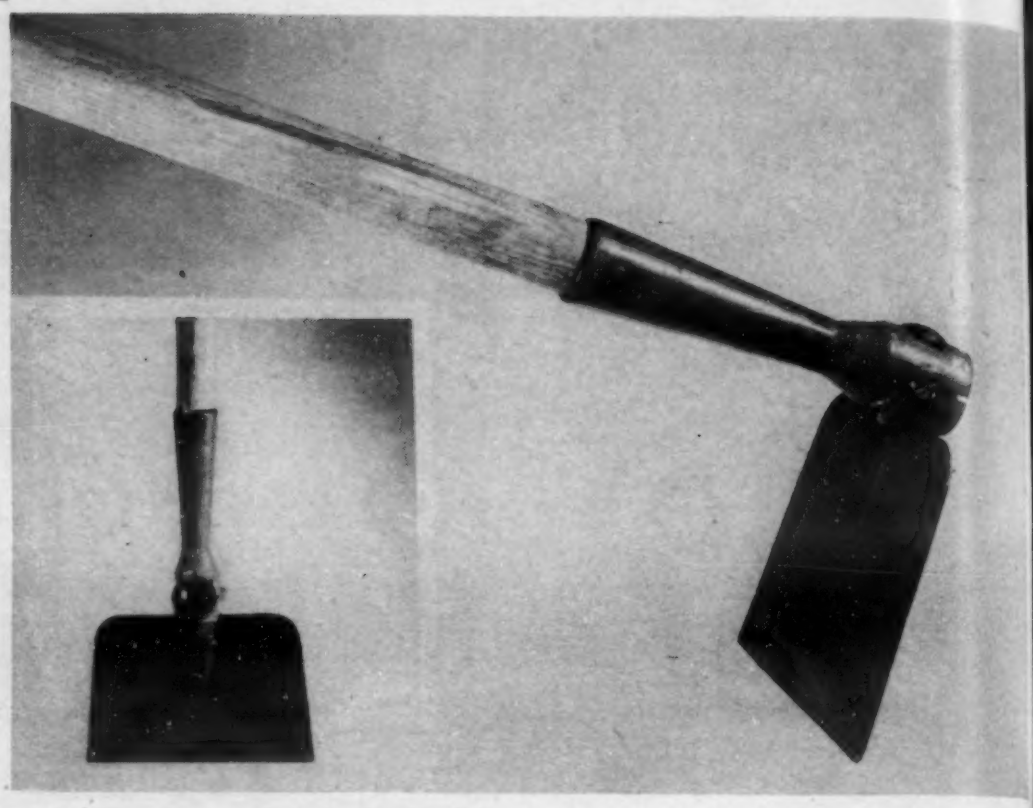
STEEL AND RUBBER LATHE COLLET

Providing from two to four times the gripping power of conventional split steel collets, this rubber and steel lathe chuck unit produced by the Jacobs Manufacturing Co. assures the highest speeds and feeds possible without danger of slipping or scoring the work. The new unit is composed of Hycar synthetic rubber, bonded and mechanically locked to hardened and ground tool steel jaws. Among the advantages of this design is the ease with which the work is tightened or loosened in the chuck, thus reducing operator fatigue and increasing productivity. The accuracy of the rubber and steel chuck is claimed to be greater than that of the split steel type. Runout at the nose and at points several inches from the nose is said to be much less than for present split steel collet chucks.

Materials at Work

MULTI-PURPOSE GARDEN TOOL

Combining the functions of a hoe, axe, edger, trencher, sickle, and scraper into a single multi-purpose garden tool, this ingenious device is known as the Adjusto-Blade Tool and is manufactured by the Coffing Hoist Co. The sturdy construction of the unit assures a long and versatile life. Heat-treated tool steel makes the blade much tougher than conventional garden tools. The threaded locking arrangement securely anchors the blade in any one of the several positions available. The handle is made of durable hardwood, fitted and riveted to the shank of the locking head.

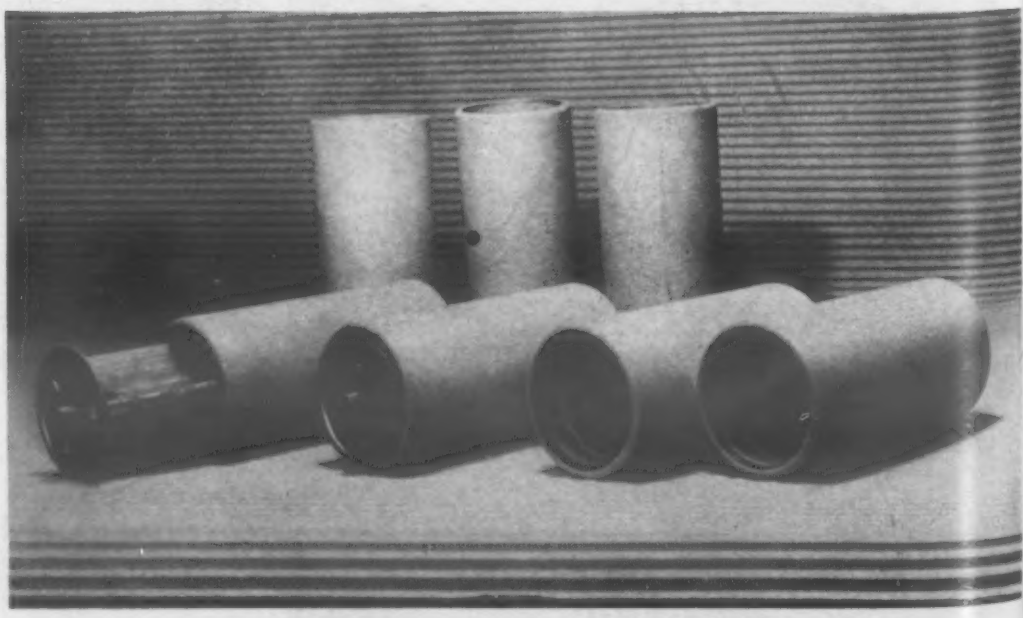


MAGNESIUM GRAIN SHOVELS

Manufactured from magnesium plate and extruded sections, these lightweight grain shovels are produced by Magnesium Company of America. Use of the light metal eliminates the warping, splintering, and rotting common to wood and increases production by decreasing worker fatigue. Fabrication is simplified and the length of life of the shovel is claimed to be greatly increased. (Photo courtesy Magnesium Company of America).

PHENOLIC TEXTILE COMPONENT

Made from Synthane, a phenolic plastic developed especially to withstand the tremendous crushing strength of nylon yarn when packaged in thousands of turns around a shaft or cylinder in textile operations, these headless package tubes are used on twisters made by the U. S. Textile Machine Co. The tubes have an annular groove machined in the inner wall near each end. This groove is engaged by a spring-backed ball which holds the aluminum arbor snugly in the tube. Outer surfaces are rough-sanded to provide the most effective grip for the yarn as the package is started, and ends are color-coded with paint to aid in identifying the type of yarn being packaged.



Materials & Methods Manual

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

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Fabricated Materials and Parts

—A Comparison of Their Design and Production Factors

by the Editors

The success of an earlier effort has shown that there exists a need for compact, concise, easy-to-get information on the design, cost and production features of small fabricated forms and the processes involved in their manufacture. In this manual the emphasis has been placed on the final form in which the various materials are to be used, rather than on the processes themselves, for the majority of small parts are purchased rather than manufactured by the ultimate product manufacturer.

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Introduction

More than five years ago there appeared on these pages the first of a long series of popular and helpful MATERIALS & METHODS manuals. That first manual was directed toward giving help in selecting small parts as to the form in which they should be made. Because of the popularity of that particular manual, it has been decided to repeat it, with some minor changes. Most of the changes are in the nature of bringing cost data up-to-date.

Despite the fact that practically every metal working plant uses a myriad of small parts, there still exists a need for better selection of fabricated parts and forms. Newer materials, improved metal processing techniques, as well as improvements in fabricating methods complicate the making of a selection. More severe operating demands call for changes in materials. The materials may require a different fabricating method even though form and function of the part remain identical.

In choosing a fabricated form, the engineer must consider the factors of functional utility, mechanical quality, appearance and production cost. When the part is required in high quantities, the factor of production cost can easily outrank the others in importance.

Selection of the fabricated form is of equal importance with the selection of the material of which the part is to be made. Each form has certain design characteristics which are as distinctive as characteristics of each material.

It is the purpose of this manual to present, in capsule form, the characteristics, cost factors and design factors of the principal methods of producing small parts. The information is sufficiently detailed to permit an engineer to determine rather accurately the possibilities of any fabricated form as an answer to his specific problems.

There are about 20 common forms in which small parts are produced. They are:

- Sand Castings
- Permanent Mold Castings
- Plaster Mold Castings
- Die Castings
- Precision Castings
- Drop Forgings
- Press Forgings
- Upset Forgings
- Cold Headed Parts
- Screw Machine Parts
- Pressed Metal Parts
- Powder Metal Parts
- Electroformed Parts
- Cut Extrusions
- Sectioned Tubing
- Impact Extrusions
- Spinnings
- Welded or Brazed Parts
- Molded Plastics
- Molded Nonmetallics

In choosing among these fabricated forms for the manufacture of a particular product, the engineer should set forth his minimum requirements as to certain selection factors, determine which forms meet these minima, and then compare or rate those that are suitable, and their relative appeal.

In the tables which complete this manual will be found discussions under headings that include: raw material cost; tool and die cost; optimum lot sizes; direct labor costs; finishing costs; scrap loss; choice of materials; complexity of design; maximum and minimum size; precision; mechanical properties; rate of output and several other factors which must be considered before a proper choice can be made.

The final table is of considerable importance in that it ties together the most common materials and shows in what forms these materials can be obtained.

Descriptions of Forms and Processes

On the pages immediately following there are briefly set forth (a) the salient features of each fabricated material and form, and the processing methods involved in their production; (b) advantages and disadvantages; and (c) illustrations of typical parts of most types, in such a way as to indicate, generally, what each method has to offer to the engineer and designer.

Sand Castings

Process Features

Sand castings are traditionally the most widely used cast forms. Their production involves (a) making a sectioned wooden or metal model (pattern) of the part or parts to be cast in the closest possible approach to actual size, with proper allowances for shrinkage in solidifying and for machining after casting; (b) packing, molding sand around the pattern in a "flask," removing the pattern (and sometimes drying the mold by baking it); (c) inserting dry sand cores in the mold to leave cavities where desired in the casting (which otherwise might have to be drilled or bored); and (d) melting (or alloying) metal under controlled conditions in a furnace or cupola and pouring into the mold cavity. The mold cavity must be provided with "sprues, runners and gates" for entry and disposition of the metal during pouring, and usually with "risers" to carry out dirt and to provide a feeder reservoir during solidification. When the metal has solidified, the casting is "shaken out" of its mold, the latter being destroyed. The sand is either discarded or returned for reuse.

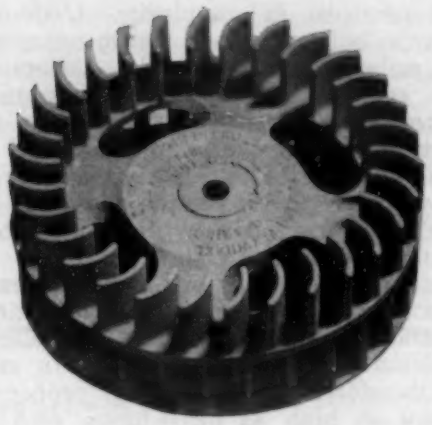
Advantages, Etc.

Sand castings usually require machining to finished dimensions, since their surfaces are rough and lacking in precision. Tolerances on sand castings are wide—±1/16 to 1/32 in. per in. being normal.

For small parts, sand casting can be rapid, since either several molds can be poured at the same time, or many parts can be cast in one flask. Tool costs are low, as expensive steel dies or molds are unnecessary. However, labor costs are likely

to be high. Design flexibility—the ability to produce complicated, cored and undercut parts in one piece—is high, since the mold is expendable and cannot interfere with the removal of complicated shapes after they have been cast.

Sand castings can be very large, but they cannot be as small nor as thin-sectioned as parts made by other methods. Gray iron, malleable iron, steel, nickel alloys, brass, bronze, aluminum and magnesium can all be used for sand casting.



Courtesy Dow Chemical Co.

Permanent Mold Castings

Process Features

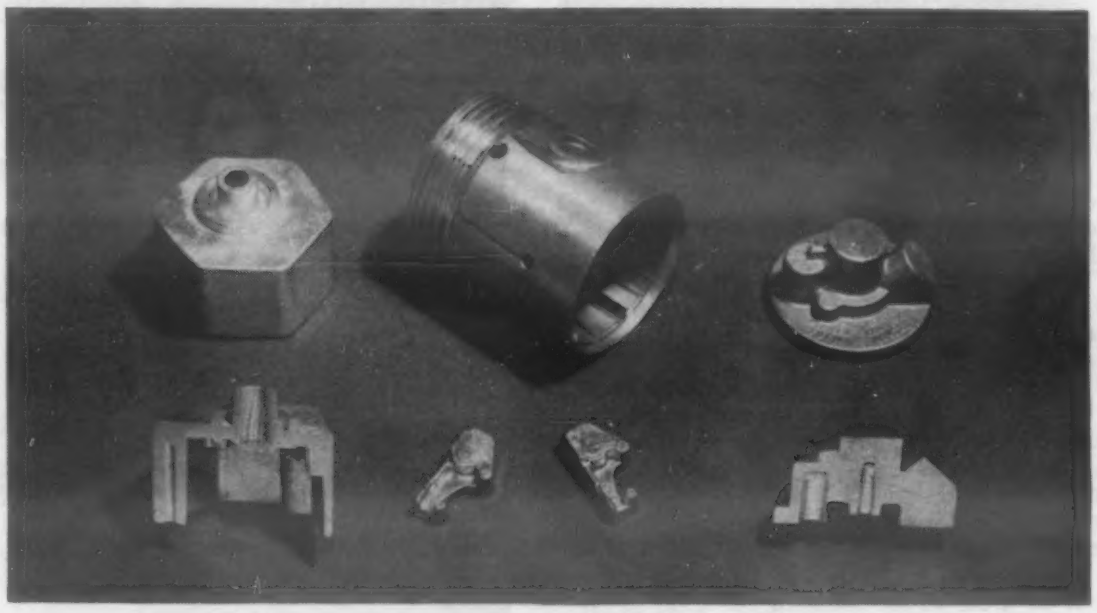
Permanent mold castings (called "gravity die castings" or just "die castings" as distinct from "pressure die castings" in England) are produced by pouring molten metal under a gravity head into metal molds. Molds are made in sections which are assembled and clamped together during pouring and solidification of the casting.

Materials so cast include aluminum alloys, bronzes, cast iron, zinc and lead. "Slush castings" are those in which the still liquid internal metal is poured out of the casting after the outer shell has solidified; zinc and lead are used most frequently in slush castings. Small parts (aluminum alloys, bronzes, steel, etc.) are often centrifugally cast in metal molds.

Advantages, Etc.

Permanent mold castings are usually dense and fine-grained and can be made with better surfaces and to closer tolerances than sand castings. Tolerances must be wider than with die castings and plaster mold castings. Tool costs are lower than for die casting, but higher than for sand and plaster mold casting. Production rates are lower than for the same parts made by die casting.

Permanent mold castings thus stand somewhere between sand castings and die castings in respect to possible complexity, dimensional accuracy, mold or die costs, direct labor costs and production rates. In many cases, permanent mold castings provide an attractive compromise where the ultimate, either in complexity of one-piece construction or in narrow tolerances or ultra-high production, need not be met.



Courtesy The Permold Co.

Plaster Mold Castings

Process Features

The fine finish and higher accuracy of plaster mold castings make them of increasing importance for certain types of parts. Plaster used for the mold material is gypsum with strengtheners and setting agents added.

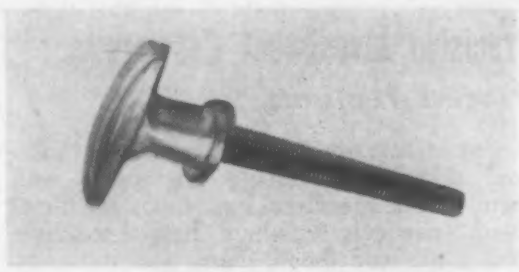
A plaster-water mixture is poured around the pattern of the part to be produced. When the plaster is partially set, the pattern is removed. Match plate patterns, often incorporating many metal patterns (separately removable), are used. The upper and lower halves of the mold are then separately baked to remove moisture and increase permeability of the mold to air and gases. Any cores (also plaster) are baked and assembled with the mold parts. The metal is then poured. Each plaster mold is broken after the casting is produced.

Plaster mold castings are seldom made in metals with melting points above 2100 F. Yellow brass is the most popular material for this type of casting, with aluminum bronze, manganese bronze and aluminum alloys also being used.

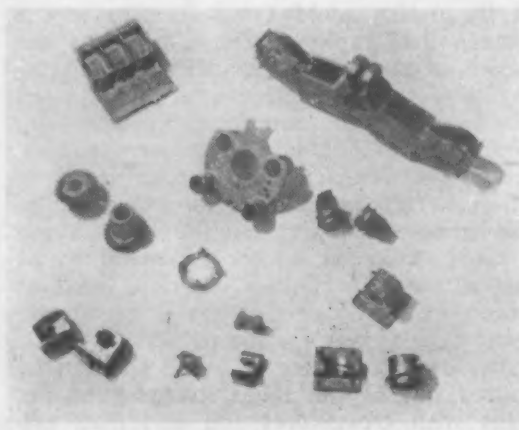
Advantages, Etc.

Plaster mold castings have surface finish and surface detail far superior to sand castings. Castings having tolerances of ±0.005 in. per in. or greater can be made directly to size. Thin walls can be cast. In addition, finish and reproduction of fine surface detail is superior to that of sand castings. However, metallurgical structure in some metals is inferior. Molding costs are higher than for sand castings, but subsequent machining costs are less because of the finish and surface detail possible.

Castings made in plaster molds are slightly inferior to die castings and permanent mold castings with respect to dimensional accuracy and surface quality. Castings of this type are usually most economical for short run work, but with a highly mechanized setup can compete on a cost basis with metal mold castings for mass-produced parts. Medium run lots seem most attractive as a field for plaster mold castings. Such cases would be those where quantities involved could not absorb the quire too much machining if made as sand cost of metal molds, but which would re-castings.



Courtesy Briggs Manufacturing Co.



Die Castings

Process Features

Die castings are produced in fast working machines that transfer or inject under pressure the right amount of molten metal into a water-cooled metallic die set that remains closed until the casting is solid. After the casting has solidified it is removed from the die by means of mechanically operated ejector pins.

Three types of die casting machines are used:—(a) Gooseneck or direct air injection machines, in which the metal is held in a pot and forced through a gooseneck outlet into the die by admitting air under pressure; (b) plunger machines, in which air or hydraulic pressure pushes a cylinder immersed in the molten metal, injecting the latter into the die; and (c) cold-chamber machines, which have an injector ram in the cylinder, the ram being filled by ladling in the proper amount of molten metal.

Gooseneck machines are used for aluminum, plunger for zinc, and cold-chamber for magnesium, copper alloys, and increasingly for aluminum. Pressures run 500 to 600 psi. for gooseneck, 1500 to 3000 psi. for plunger and 600 to 20,000 psi. for cold-chamber. Production rates are up to 110 shots per hr. with gooseneck, 100 to 400 (in extreme cases 800) with plunger and up to 90 with cold-chamber. On any machine the use of multiple cavity dies can increase hourly part production several fold.

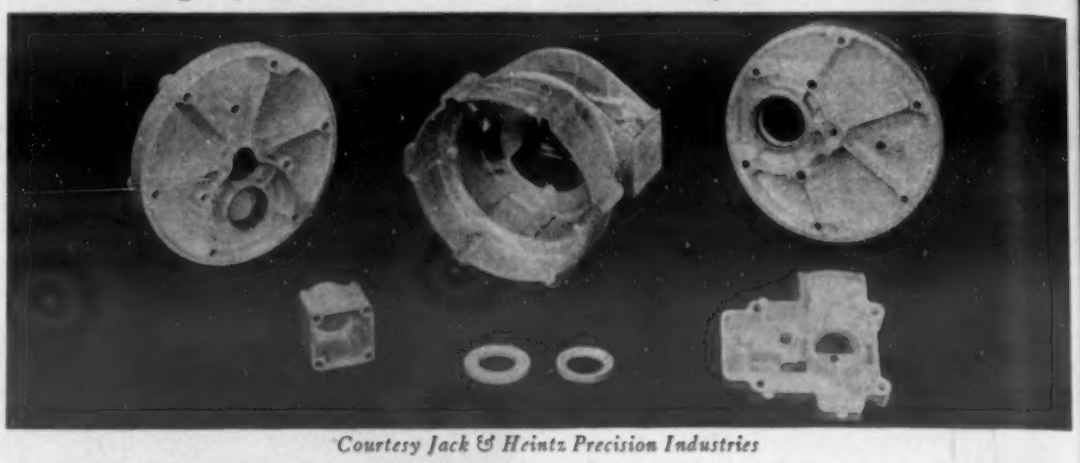
Advantages, Etc.

Die castings' greatest value lies in their high precision (tolerance as close as ±0.001 in. can be held) and the high production rates achieved. They are among the most economical of metal forms since they seldom need to be machined because of their high rate of production.

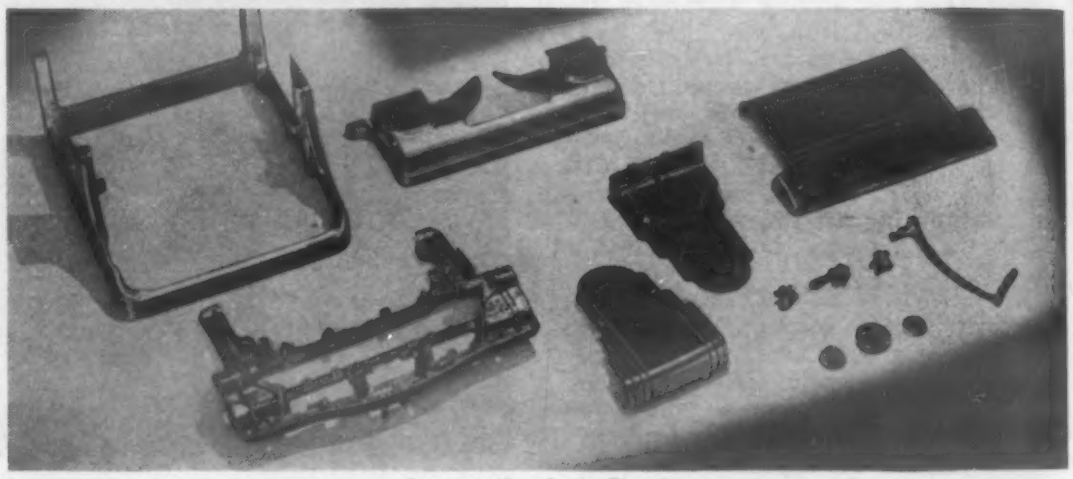
Die costs are a sizable factor, although not so great as for some of the solid-metal forming methods. Casting shapes are somewhat restricted in complexity. Undercuts and cross holes cannot be cast in unless the dies embody expensive slides, collapsible cores, etc. The cost of these extra features can sometimes be justified; sometimes the use of an exterior undercut saves metal by providing uniform section thickness; or, a part with necessary undercuts might still be less expensive to make by die casting than by other methods.

Because of die costs and heat problems, die castings are chiefly made of low-melting-temperature metals including zinc alloys, aluminum and magnesium alloys. In general, therefore, their mechanical properties are not as high as metal-forms such as machined steel, forgings, and high strength sand castings. Die castings, as a class, are weak, porous and unsound, and are ideally suited for many applications where maximum strength is not required. Applications of a structural or engineering nature are included.

Most die castings are made of zinc alloys, although the quantity made in aluminum and magnesium alloys is increasing rapidly. An advantage on the side of zinc alloys is the simplicity of plating when necessary. When die castings with high mechanical properties are desired, brass can be used, although die costs are thereby increased considerably.



Courtesy Jack & Heintz Precision Industries



Courtesy New Jersey Zinc Co.

Precision Investment Castings

Process Features

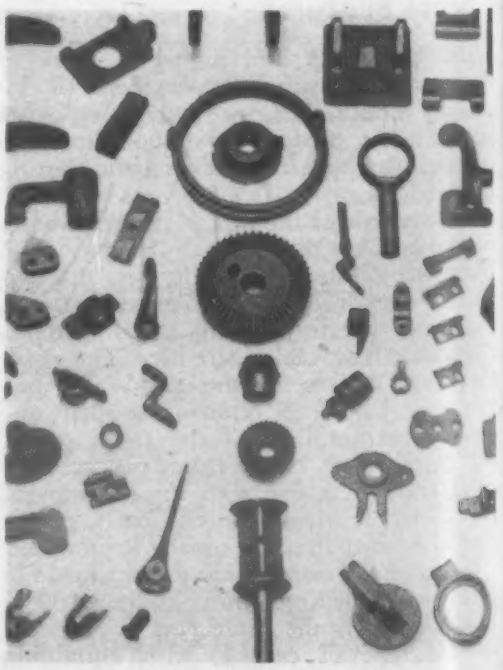
Precision castings, which came into industrial prominence during the recent war, seem destined to remain as important metal forms, particularly where hard-to-machine metals are concerned. Parts are made by (a) the production of a split section master metal mold from a replica or model of the casting; (b) pouring wax into the cavity of the master mold (thus forming a wax pattern that duplicates the dimensions and details of the original model), and removing the split section master mold; (c) placing the wax pattern in a flask and pouring the mold investment (plaster, ceramic or other castable material) around it; and (d) when the investment mold has hardened, melting out the wax, leaving a mold cavity in which the metal to be cast is poured. (Other materials, such as frozen mercury, are used by some processes instead of wax for the pattern.)

Because the pattern is liquid and can be poured out of the mold, complicated designs with cross cores and undercuts can readily be produced. The investment is broken up to remove the casting, hence can be used only once. The master mold lasts indefinitely.

Model, wax and investment materials are selected so that expansions and contractions involved tend to cancel each other. Final casting of the liquid metal is done centrifugally, under pressure, by a vacuum or statically.

Advantages, Etc.

Designs of precision investment castings can be intricate because the mold in which the final casting is made is broken up and discarded when the casting is removed. The method produces castings which combine the permissible design intricacy of sand castings with precision close to that of die castings (tolerances can be from ±0.005 in. to 0.003 in.). Considerable skilled labor is involved, and there is some material waste in the form of sprues. (In many cases the sprues can be remelted and cast with practically no loss.) Normally little or no machining is ever required on the castings.



Production rates can be fairly high, but extremely small parts cannot compare with die castings or powder metal parts. Costs can be low, particularly on moderate quantities or on parts where production by other means would entail considerable machining. Precision castings are made industrially in brass, bronze, Stellite, Vitallium, stainless steel, aluminum and magnesium alloys, and many other metals. Much of the value of the method lies in the fact that it can be used to make intricate castings of materials that are virtually impossible to machine.

Precision castings fill a need for parts with dimensional tolerances closer than attained in sand castings, with shapes too complicated for powder metal parts and made of materials with melting points too high for die casting.

Courtesy Westinghouse Electric Corp.

Drop Forgings

Process Features

Drop forgings are produced by working a billet (usually round-cornered square stock) of hot metal to approximately final form by repeatedly hammering it, by means of a board, steam or air drop hammer, while it is enclosed in suitable dies. The die block usually has three impressions —an edger, a blocker, and a finishing impression—which work the stock in progressive stages. Usually, no intermediate heating is required. Surplus metal—flash—surrounding the forging is removed in a trimming press.

In the board drop hammer the force of the blow is imparted solely by the falling weight of the ram containing the upper die; the speed of fall is about 14 ft. per sec. Large board drop hammers are rated at 5,000-lb. falling weight. Steam or air drop hammers add positive pressure to the force of gravity so the ram falls at the rate of about 30 ft. per sec. Present steam-hammer ratings go up to 50,000 lb.

Production rates of forgings vary, depending upon the material, size of hammer, etc. For hammers of greater than 2,000-lb. falling weight, output can be between 15 and 30 lb. of forgings per hr. per 100 lb. of falling weight. The higher rates apply to low-carbon steels and the lower to high-carbon steels and light metals.

Advantages, Etc.

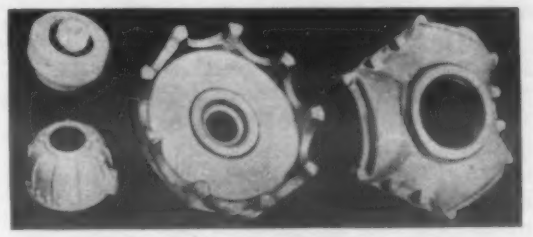
All forgings, but particularly drop forgings, are noted for their strength or toughness, particularly in the direction of fiber flow. Forgings are superior to most other metal forms in this respect.

Drop forging is usually favored for the larger sizes of forgings, although some forgings weighing but a few ounces are produced this way. Draft must be greater in drop than in press or upset forgings. Design intricacy is limited in comparison to castings. Loss of metal, through flash, is greater in forgings than in die casting or powder metallurgy, but much less than in sand casting. Tolerances can be held to ±0.010 to 0.015 on small parts with ±0.004 in. possible at extra cost. This tolerance range is better than with sand casting, and the finish attained is much superior.

On the other hand, forging dies cost much more than casting patterns. Die cost is so great a factor that forging is seldom used on any but high production work. Cost of drop forgings and castings in similar materials are comparable. The common materials for drop forgings are carbon steel, brass, bronze, aluminum and magnesium alloys and special steels.

There are many cases, however, where desirable mechanical properties cannot be attained through any process other than forging.

Courtesy Chambersburg Engineering Co.



Press Forgings

Process Features

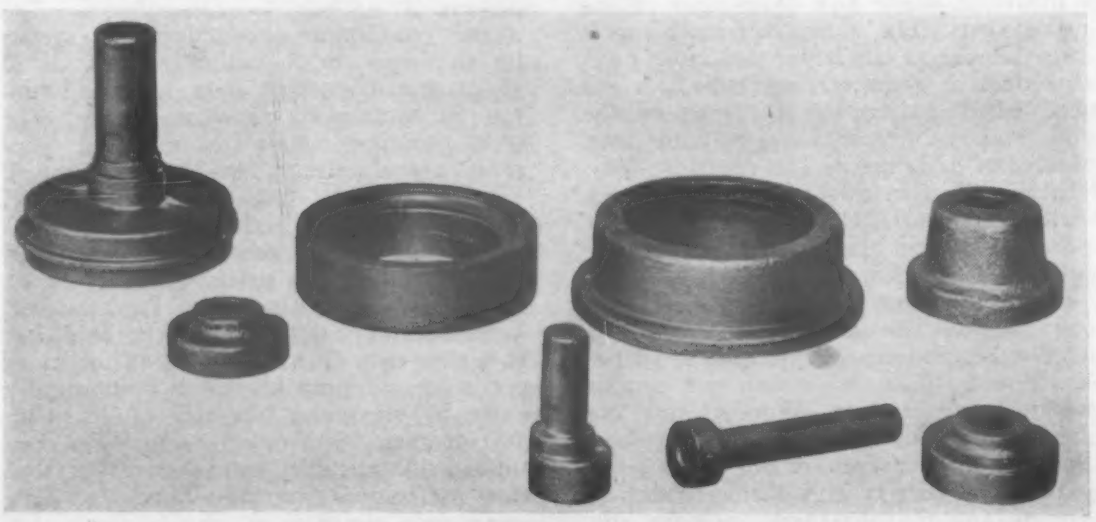
Press forgings (also known as hot pressing, cold pressings, or die-pressed parts) are made in either hydraulic or mechanical presses. Usually a hot billet or slug of correct diameter and length is placed in the die impression and pressure exerted to make the metal flow and fill the die cavity. Sometimes cold slugs are used. In some cases the part is formed in one operation; in others by stages with several die impressions. No preliminary operations, such as edging or blocking, can be performed.

Parts are ejected from the opened dies by means of knockout pins; therefore, little or no draft is required. Dies are of three types—open, with one plane of parting; extrusion (the metal flows into an annular space between a punch and the die cavity); and split dies, which permit the forging of flanges and other projections that otherwise could not be removed from the dies.

Advantages, Etc.

Press forgings can be made to somewhat closer tolerances, require less draft, and permit greater design intricacy than drop forgings. Although generally used for smaller parts than the drop hammer process, press forgings have recently been made in large size (particularly in light metals) by means of presses of large capacity.

A large share of nonferrous forgings are press forged and steel forgings (small- to medium-sized gear blanks, for example) are frequently made in presses. With the exceptions noted, press forgings are similar to drop forgings in their competitive relation to other metal forms. For high production work, where their degree of precision is adequate, and especially where highest mechanical quality is required, forgings of any type will be satisfactory.



Courtesy Tube Turns, Inc.

Upset Forgings

Process Features

Upset forgings are made from bar stock in forging machines or upsetters. The heated bar is held between two stationary gripping dies, and struck axially by a heading tool. The stock is thereby shortened axially while being thickened over part of its length.

Many types of upsets can be produced in a given machine by varying the heading tool or gripping dies. Punches are used instead of heading tools when a forging is to be pierced or made hollow. It is common to upset-forge a part in successive steps without reheating by striking the stock with a series of heading tools as the stock is progressively shifted in the gripping dies.

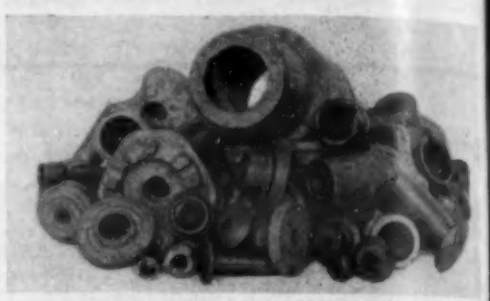
The greatest length of stock that can be upset is, normally, 3 times the original bar diameter, if the upset portion is not contained in a die cavity. If it is so contained, the limiting length is greater.

Advantages, Etc.

The characteristic feature of upset forgings is their bar stock basis. Small- to medium-sized forgings have been best for upsetting, although forging machines are now used for such parts as aluminum alloy cylinder heads for aircraft engines and for steel cylinder barrels. The normal maximum bar stock size handled in forging machines is about 9 in.

Upset forgings can be made to dimensional tolerances approximating those of press forgings, and slightly closer than drop forgings. Draft is midway between those two types of forgings. Upset forgings can be pierced to provide a hollow part, thus saving subsequent machining (like coring in sand castings).

As with other forgings, upset forgings are tougher than other metal forms. They often require less machining to size than sand castings, about the same amount as permanent mold castings, and more than die castings or powder-metal parts.



Courtesy The National Machinery Co.

Cold Headed Parts

Process Features

Cold heading is really a specialized form of upset-forging, done in somewhat different machines and on cold stock. Wire is taken directly off a reel, cut to required lengths, and automatically put through the upsetting operations. The stock is gripped between dies in a header and pressure is applied upon the stock ends to produce a thickened section or flange wherever desired. Modern headers also can do some "extrusion" by driving the end or all of the shank into a hole of smaller diameter, with a proportionate increase in length.

Production can be rapid (*e.g.* up to 400 per min.) and the only supplementary machine-operations required are trimming, thread cutting or rolling and drilling of cross holes. The stock is cold-drawn wire up to 1 in. in dia. (usually less than ⅝ in., however) and ¼- to 7-in. lengths (for steel). Carbon steels, alloy steels, stainless, aluminum alloys, brass and bronze—all essentially ductile materials—are commonly cold-headed.

Advantages, Etc.

Cold headed parts resemble those made on the screw-machine in many respects. The process is rapid, and involves no metal waste (in contrast with screw-machining). Because no heating is required (as in forging), surface finish is excellent, die costs are lower, and tolerances can be more closely held (down to ±0.002 in. per in.).

Design intricacy is relatively limited, of course, the flexibility being of the same order as upset forging. The amount of upset possible is less than in hot forging, and part size is limited in comparison. The costs for the process show up best on simple flanged or headed products such as bolts, screws and rivets in extremely large lots.

In small sizes or small quantities, especially where a threaded stem or the use of brass is specified, screw-machining may be preferable to cold-heading. Although tool costs are high, cold heading is one of the least expensive fabricating processes where large production is required and the design is suitable.

Spinnings

Process Features

Metal spinnings are made by dishing sheet metal disks as they revolve on a lathe, using simple tools. The first step is the preparation of a wood or metal "form" of the exact shape and dimensions of the finished part. The form is fastened to a lathe (similar to but larger and more powerful than a wood turning lathe), a flat metal blank is clamped in front of the form, and both form and metal are then revolved at high speed. The operator (who must be skilled in this art) presses a long blunt-ended tool (hardwood or steel) against the metal blank, forcing it to flow snugly over the form.

The forms serve the same purpose here as do the dies in stamping and forming, and can be used repeatedly. Simple shapes require one form, more intricate shapes several in progression. Wood forms are used for small quantities or large sizes; steel forms for large quantities and small sizes.

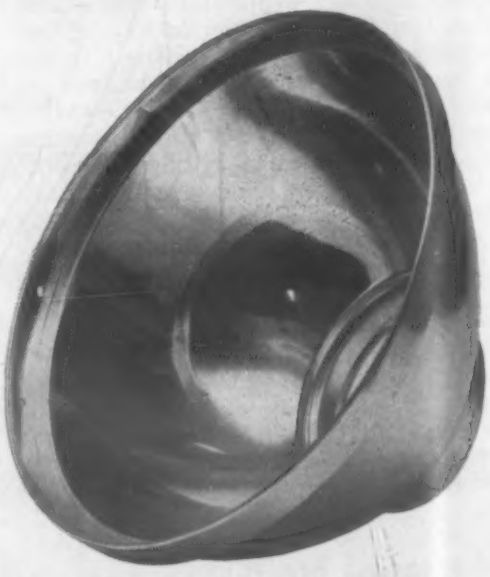
The metal part is work-hardened during spinning and thus has extra strength and hardness.

Advantages, Etc.

The characteristic features of spinnings are their low cost for relatively small-quantity production, their generally concentric, round or cylindrical shapes, and their fine finish. Designs can be intricate, but must always be of circular symmetry to fit the process.

For economical production soft metals up to ¼-in. thick, stainless steel up to ⅛ in. and low-carbon steel up to 3/16 in. can be successfully spun at present. The most common metals for industrial spinnings are aluminum, steel, stainless steel, copper, bronze, brass, nickel, tinplate, magnesium, Monel and Inconel.

Tolerances are generally wider than ±0.015 in.—not so precise as stamping or die casting, but better than sand casting. Tolerances of ±0.005 in. can be held, but at higher cost. Quantities of 5000 or more per piece are probably more economically made by stamping, but lots of 20, 100, 500 or even 1000 can be reasonably considered as possible spinnings. The tool costs for spinning are usually negligible in comparison to die or pattern costs for stamping, plastics molding or casting.



Courtesy Milwaukee Metal Spinning Co.

Screw Machine Parts

Process Features

Screw machine parts consist not only of nuts, bolts, screws, etc., but many other types of pieces having a wide range of uses. Screw machines, both manual and automatic, perform many operations including turning, forming, facing, drilling, boring, threading and cutting-off—often several of these operations are carried on simultaneously. Certain shapes and steps require the use of auxiliary machines.

Sequence of operation as well as the actual operation is controlled by cams which must be designed for each different shape of part. Single- and multi-spindle machines are used, depending upon the complexity of the part.

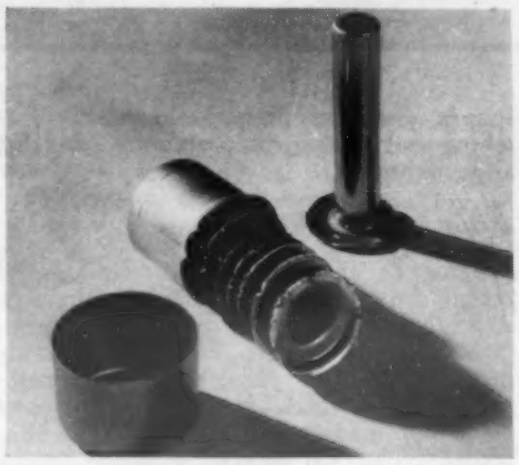
Advantages, Etc.

The high rate of production of screw machine parts are one of the chief assets, together with the extremely close tolerances which can be held. Production rates vary according to material being cut, but can reach several thousand parts an hour. Surface finish, again varying somewhat with the material, is generally superior. Mechanical properties are generally high.

Since the largest diameter of the part governs the size of stock required, there is often considerable scrap loss in producing screw machine parts. Design intricacy is limited because the parts must have surfaces of rotation (can be modified by subsequent operations). Interior and exterior undercuts are readily possible, providing an advantage over die castings and powder metal parts. Parts, generally, are restricted to under 2¾ in. in dia. and 6 in. long, although some machines are now available for larger parts. Extremely small parts, such as watch pivot shafts, are readily handled on screw machines.

Automatic screw machines are not economical for small run jobs (less than 1,000 parts) because of high tool and set-up costs.

Materials most used for screw machine parts are free-machining steels, free-cutting brass, aluminum and magnesium alloys, other nonferrous metals and plastics. Materials costs are relatively low, as is direct labor cost.



Courtesy Allegheny Ludlum Steel Corp.

Stampings and Formed Parts

Process Features

Stampings are parts made by blanking, pressing or forming parts out of sheet or strip metal by means of presses or drop hammers. Involved are (a) punching out a flat blank; (b) forming this by bending or forming in a suitably shaped die; and often (c) drawing the metal by stretching it over or between parts of the die or punch.

Simple stampings may require only one press operation, but deep drawn shapes often require several forming steps before the final shape is achieved. In the case of rather simple stampings, two operations such as blanking and forming might be combined, as would forming and piercing.

Advantages, Etc.

Pressed metal parts are mass-production forms, and on runs of 10,000 pieces or more it is difficult for other forms or methods to compete. Their manufacture involves high tool costs, low material costs, medium labor charges and some waste. Waste can be reduced by properly planning the blanking of the sheet or strip, and by using portions of the surplus metal as raw materials for smaller parts.

With sheet metal as the raw material, pressed metal parts can have extremely thin sections. Production rates of as high as 3,000 per hr. can be maintained with tolerances of ±0.001 on small pieces. On larger pieces tolerances generally are greater than 0.003 in.

Designs of pressed metal parts are limited to those which can be made of sheet metal, although combinations of stampings have been brazed together to make parts competing with forged or cast parts. Most any metal produced in sheet form can be used for pressed parts, although aluminum alloys, steel, stainless steel, brass, Monel and a few others are used most extensively.

Powder Metallurgy Parts

Process Features

Fabrication of small parts by powder metallurgy methods involves (a) pressing of metal powders in a mold or die to form a weak, "green" briquette of roughly final shape, (b) "sintering" the briquette, that is, bringing it to service strength by heating it to some temperature below the melting point of at least one (usually all) of the constituents, and in many cases (c) resizing or coining the sintered part to final, exact dimensions. Coining is avoided when possible to lower production costs.

The powders used must be carefully selected for purity, pressability and size, and are blended under controlled conditions, for best results. Presses used are either fast-working mechanical "tablet" presses (especially for very small parts) or slower-working hydraulic presses for larger parts. Dies are usually expensive and must be lubricated—the lubricant usually being mixed with the powder. Double-acting presses and die sets permit the manufacture of more intricate shapes than would otherwise be possible.

Production speeds usually run from 200 to 2000 parts per hr., but even higher speeds are possible and in use, some high-speed rotary presses turning out over 300 parts per min. A variety of materials are worked by powder metallurgy methods, but those of most interest to the designer of small machine parts or industrial hardware are iron, steel, iron-copper, copper and brass, with or without admixtures of graphite, tin (with copper), tungsten (with copper and others), etc.

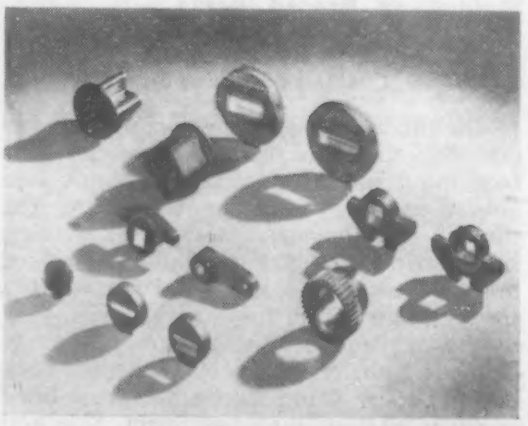
Recent improvements in powders, press sizes and speeds, coining practices, etc. continually lead to closer tolerances, larger sizes, higher rates or better properties than those considered feasible a while ago. Even materials-limitations are being broken down, with strong iron and aluminum parts now in commercial production, and stainless steel parts in the offing.

Advantages, Etc.

Powder metallurgy is able to provide certain structures or metal combinations that are not producible by melting (and, therefore, by the other methods discussed in this manual). For such work—*e.g.* the manufacture of self-lubricating bearings, tungsten-carbide tools, porous metal filters and copper tungsten and other duplex-structural contacts—it is competitively out of reach of the other processes.

It is also being used increasingly for making small parts on a mass-production scale to very close tolerances, in direct competition with machined parts. Tolerances can be held closer than ±0.001 in. and production speeds of 2000 per hr. are not unusual, although ±0.005 in., without coining, on axial dimensions is generally accepted. The method involves fewer total operations than some of its competitors. Costly machining is largely eliminated and material waste is at a minimum because parts can be made directly to finished dimensions.

On the other hand, the shapes possible in powder metal parts are relatively simple. Part size is still generally limited by available press capacities. Raw material costs are comparatively high and the mechanical properties of powder-compacts inferior to those of many other forms. Tool costs are high, but labor charges are low. The process is best adapted to large-quantity production, although it has been successfully used for short runs. For machine parts powder metallurgy thus excels chiefly for extremely close tolerance work on a reasonably large production basis, where considerable machining would be involved in the usual manufacturing practice. Of course, for certain special-structural effects or special materials powder metal parts are in a class by themselves.



Courtesy New Jersey Zinc Co.

Electroformed Parts

Process Features

Electroforming as a method of producing metal parts is an extension of electroplating. A mold, termed the matrix, is made from a master pattern of the part to be formed. The matrix is placed in an electroplating bath where the form of the part is built up by electrodeposition. The matrix is then separated from the electrodeposited metal. The resulting part is an exact duplicate of the master pattern.

Metals which can be electroformed include iron, copper, nickel and chromium. To meet special requirements, electroformed parts can be plated or can be built up in layers of different metals. Electroformed parts can be heat treated, welded and machined.

Advantages, Etc.

Designs of electroformed parts can be extremely intricate and contain minute details. Tolerances as small as ±0.0002 in. can be held. Fine surface finishes of around 5 micro-in. (R.M.S.) are easily obtained. Parts with sections up to about ½-in. thick can be practically produced. As for shapes, the process is most applicable to parts with flat contour shapes and to hollow products of any cross sectional design, including tapered, round, rectangular, and elliptical sections. Parts can be made of iron, copper, nickel and chromium.

Electroforming is a high precision process and, consequently, production costs are relatively high. It cannot compete with other processes in the mass production of parts where the tolerances are large or moderate and where high surface smoothness is not required.

Sectioned Tubing

Process Features

Sectioned tubing products are made from mechanical tubing which is manufactured specifically for further processing and fabrication. Such tubing is of uniform and high quality, has good machining qualities, relatively high finish, and is produced to close tolerances and in a wide range of materials, analyses, shapes and sizes. In some aspects, they are a specialized application of extruded and cut parts.

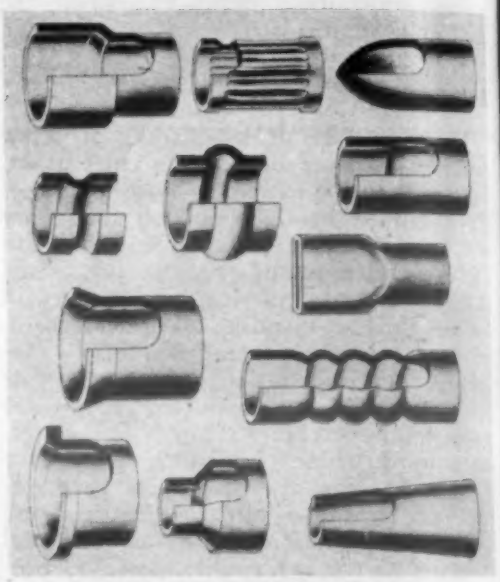
The principal materials in which tubing is produced are carbon, alloy and stainless steels, copper alloys, aluminum and its alloys, magnesium alloys, and nickel and nickel alloys. Specialty tubing is made from a number of other less common materials.

Sectioned tube products are produced by the following forming methods: bending, swaging, hot and cold spinning, upsetting, flanging, flaring, expanding, flattening and sealing, beading, and grooving, and machining.

Advantages, Etc.

Some of the important advantages of tubing are savings in weight, inherent high structural strength, and reduction in fabricating time and costs. Particularly in the field of machined parts, tubing eliminates or greatly reduces machining time and costs. For many parts, such as long, thin-walled cylindrical objects, sectioned tubing is the only answer. On the other hand, there are many uses—for example, bushings, seals, retainer rings, metal washers, liners, gaskets, etc.—in which tubing competes with bar stock, punchings and stampings, powder metallurgy parts, and castings.

Cut tubing is an extremely economical form, and has sufficient accuracy for many precision applications in small parts.



Courtesy Republic Steel Corp.

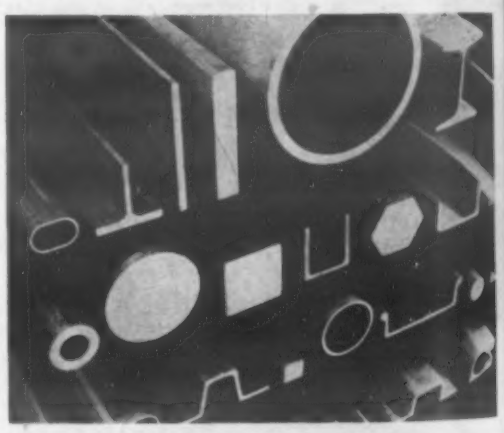
Cut Extrusions

Process Features

Certain materials can be purchased in extruded form, coming in long lengths with a special cross section uniform throughout the length of the piece. Extrusions are then cut transversely to produce parts shaped like the special cross section, but with thicknesses equal to the cut lengths. The cross-section, in any case, must be one capable of extrusion at the mill (by pushing hot metal through a restricted die orifice), and might be a solid circle, a hollow circle, a T, an L, a V, a rectangle (solid or hollow), or some intricate and irregularly shaped variation of any of these.

Advantages, Etc.

Extruded and cut shapes offer rather simple means of obtaining irregular or unsymmetrical shapes that are difficult to produce otherwise plus the excellent mechanical properties of extruded materials. The method is especially applicable for parts having a uniform width or diameter along their thickness or length. Brass and bronze, aluminum alloys, magnesium alloys, lead, tin and zinc alloys are available as extrusions and can be cut into small parts by this method where design permits. (Some simple shapes are now being produced as extrusions in steel.)



Courtesy Dow Chemical Co.

Welded or Brazed Parts

Process Features

The production of many complex designs can be achieved most economically by combining several materials or forms into one assembly by welding or brazing the components together. Resistance welding and brazing are most commonly used for this purpose, although arc and gas welding are used extensively for massive assemblies.

Brazing can be done by furnace, torch, dip, salt bath, resistance or induction heating methods, using copper, brazing-brass or silver alloy as the filler metal. Selection of the brazing alloy depends upon the materials to be joined and the type of joint.

Advantages, Etc.

The chief advantage of brazed or welded assemblies in the field of small parts is that they permit the production of intricately shaped products in shorter times than might be possible otherwise.

Low carbon steel stampings, tubing, rod and simple machined shapes are the most popular components.

Precision is fair, but usually less than could be obtained by machining or die casting. Tool charges are low, but labor charges somewhat higher than for many other forms.

Courtesy Westinghouse Electric Corp.

Impact Extrusions

Process Features

Impact extrusions result when suitable dies and presses apply pressure to a cold flat metal blank and cause it to flow through a narrow opening, giving an elongated part of uniform cross section. The opening is the annular orifice between the wall of a stationary bottom die cavity and the surface of a punch which presses the blank into the die cavity while the metal flows upward through the space between punch and die.

A process similar to this in many respects is the Hooker extrusion process, in which a cup-shaped blank is used and the metal is extruded ahead of the punch through an annular orifice between the punch and die, instead of being pushed back over the punch.

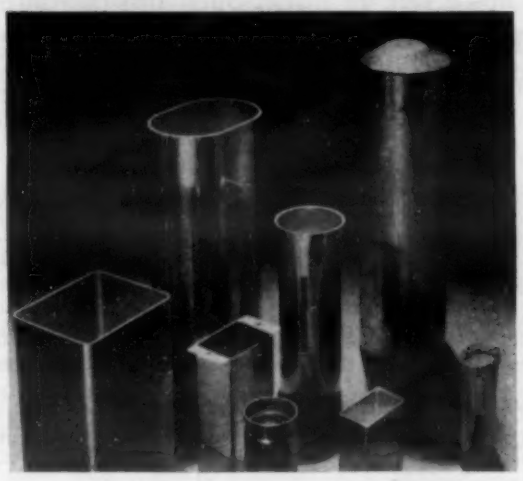
Impact extrusion is in some respects similar to coining and, indeed, coining presses are often used for small impact extrusions. Press operating speeds are high, approximately those of punch presses generally.

Advantages, Etc.

Impact extrusions are familiar to many in the form of collapsible tooth paste and shaving cream tubes made of pure tin, tin-lead alloys or aluminum. The process is also extensively used, however, for many industrial products that are characteristically shell- or cup-shaped, and in competition with deep-drawn sheet metal. (See under "Stamping"). Relatively shallow articles are cheaper to produce by deep drawing; with some shapes, however, the cylinder length is too long in relation to the diameter for drawing, and impact extrusion must be used.

Shells or cup-shaped parts with heavy bottoms, integral bottom lugs or bosses, and walls from 0.005 in. to approximately ¼ in. are well suited to the process. Equipment is available to produce shells as large as 5 in. in dia. and 16 in. long. Alloys commonly used are 2S, 3S, A51S and 61S aluminum. The latter two alloys are heat treatable, providing relatively high strength properties and good machining characteristics.

Impact extrusion has been intensively developed for aluminum parts and is also applied to zinc, brass, tin and lead on a commercial basis. The Hooker process is used with brass, copper and aluminum.



Courtesy Aluminum Co. of America

Molded Plastics

Although many of the uses of plastics are well defined, and seemingly suited to no materials other than plastics, there are also many instances where plastics parts should be considered along with several possible metal forms. It is not in the realm of this manual to explore the wide range of plastics formulations. It is sufficient to point out that an extremely wide combination of characteristics can be obtained in plastics.

Depending upon the specific material, plastics can be molded by injection, compression or transfer methods, cast, pressed to simple shapes, be extruded or laminated.

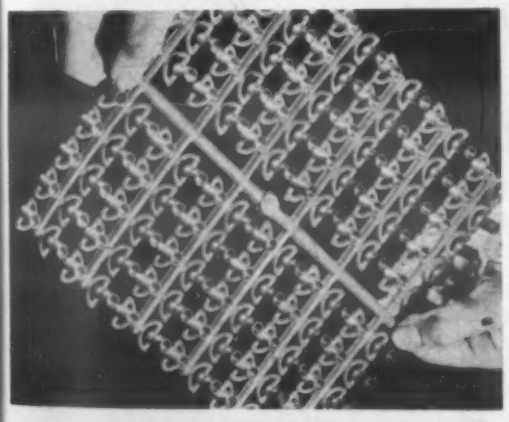
Nearly all plastics are good electrical and thermal insulators. The number of fabricating processes permits considerable flexibility in design, although molded parts, for instance, have essentially the same design limitations as die castings, forged or powder metal parts.

Plastics parts can be produced rapidly—often in multiple cavity molds—at rates only exceeded by a few metal forming processes. Dimensional accuracy is within the precision range; ±0.005 in. per in. are commercial tolerances on molded parts.

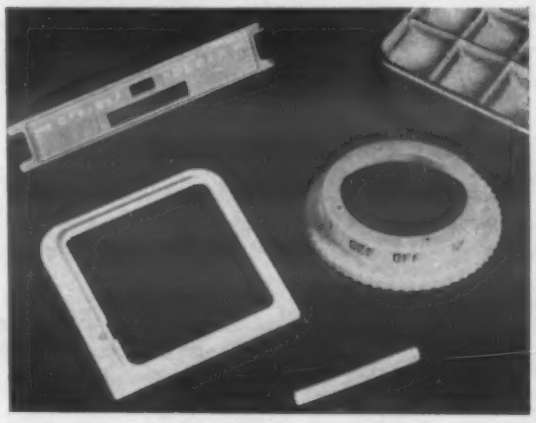
Raw material costs per pound are rather high for most plastics, although on a volume basis they may be less than many metals. Mold and die costs are relatively high, but labor charges per piece can be low on automatic operations.

Some plastics have good mechanical strength, but most must be used at temperatures below 212 F and virtually all below 350 F. For certain applications the advantages of both metals and plastics are combined by means of molding the plastics around metal inserts.

Where strength/weight ratios are important it is often wise to consider plastics.



Courtesy Eastman Kodak Co.



Courtesy Monsanto Chemical Co.

Molded Nonmetallics

Several nonmetallic materials compete to a limited extent with metals on specific applications. In other cases the unique properties of these materials cannot be met by any other materials. In either instance it is desirable that the materials be formed into shapes that compare with metal forms. Most of the shapes are attained by molding processes that are identical with or similar to molding of plastics.

Materials falling into this group include natural and synthetic rubbers, carbon, silicones, certain types of ceramic materials, and such combinations as mica and glass.

Shapes produced in these materials must be relatively simple, because the materials do not flow in the same manner as metals. However, some degree of design complexity is provided by extruding, which is applicable to most of these materials. Materials such as hard rubbers, ceramics and other nonmetallics of relatively high hardness can often be finished to close tolerances by grinding after forming. As-molded tolerances are not too close in most of these materials, since most require a firing period or heat cure after forming.

Production rates on most formed parts of the moldable nonmetallics are not high, since with only a few exceptions can the work be made completely automatic.

The rubber and rubberlike materials, including silicones, cannot operate at temperatures over 350 F, but the ceramic, carbon and mica-glass combinations can withstand considerably higher temperatures.

Courtesy Stalwart Rubber Co.

Courtesy Polymer Corp. of Penna.

Cost, Design and Production Comparisons

Specific comparisons between one fabricating method or fabricated form and another is obviously dangerous. Unless accurate knowledge of the part under consideration is at hand, no final choice can be made. Such information would have to include number required, the required speed of output, cost limitations, etc.

However, the general details of the principal fabricated forms and their production processes can be set forth in such a way as to aid in selecting that form or forms which seem to offer the most possibilities for the considered part.

It is unlikely that a final selection could be made from this list. In fact, we strongly advise against such procedure, since there are exceptions to most of the data presented here. It is recommended that the following tables be used to choose two or three possible forms in which a part could be ob-

Cost Factors

Fabricated Form	Raw Material Costs	Tool and Die Costs	Optimum Lot Sizes
Sand Castings	2½¢ per lb. for iron to 20¢ per lb. for magnesium.	Pattern costs are low as compared to making dies and molds.	Wide range—from 100 to 10,000.
Permanent Mold Castings	Medium cost — aluminum, copper, magnesium alloys most used — iron and steel sometimes used.	Moderate—less than die casting, but more than for other casting methods.	Large quantities—in the thousands.
Plaster Mold Castings	Medium—16¢ aluminum; 18¢ bronze, etc.	Medium — between permanent mold and sand castings.	Short runs—100 to 2,000.
Die Castings	Medium—about 13½¢ per lb. for zinc, other materials somewhat higher.	High—more than other casting methods. Typical dies cost $200 to $5,000.	Large quantities — 1,000 to hundreds of thousands.
Precision Castings	High generally—the process is best suited to special alloys which are usually costly.	Low—if model is available; moderate if model must be made.	Wide range, although best for quantities of from 10 to 1,000.
Drop Forgings	Low to moderate—most used steels at a few cents per lb., but alloys up to 55¢ per lb. or more are used.	High—dies must be carefully made to withstand heat and impact—$100 to $1,000 or more.	Lge. quantities—10,000 to 100,000 or more, but used on small quantities when properties are required.
Press Forgings	Low to moderate — compares with drop forgings.	High — but usually somewhat lower than dies for drop forgings.	Medium to high production lots.
Upset Forgings	Low to moderate—as with press and drop forgings.	High—often because of large number of impressions or difficult design.	Medium to high lot production best.
Cold Headed Parts	Low to moderate—6 or 7¢ per lb. for steel wire, up to 35 or 40¢ for other materials.	Medium—sometimes to a few hundred dollars.	Large lots are best.
Stampings, Formed Parts	Low to moderate, ranging from ordinary steel to stainless.	High—$400 to $1,200 is common for dies for small parts—more for large parts.	Large lots—over 10,000 best.
Spinnings	Low to moderate. Steel 3 to 4¢ per lb., up to stainless steel sheet 39 to 50¢ per lb.	Low—form can cost from $25 up to $200.	Quantities under 1,000.
Screw Machine Parts	Low to medium—steel (4 to 5¢ per lb.) most common up to brasses (34 to 50¢), with a few more expensive materials.	Medium—$50 to $200 common tooling cost range.	Large lots best—more than 1,000 essential—the higher the quantity the better.
Powder Metal Parts	Medium to high—powders run 13 to 90¢ per lb. for iron; 20 to 25¢ for copper; 22½ to 30¢ for brass, etc.	Medium — usually more than $100; range $100 to $2,000.	Large lots best to amortize die costs — 10,000 pieces. However, small runs may be necessary.
Electro-Formed Parts	Low to high, depending upon the material used: iron lowest, chromium highest.	Medium—master mold doesn't wear out. However, due to small lots die costs may be relatively high.	Best where small lots are involved.
Sectioned Tubing	High—invariably 20¢ per lb. or over; some tubing much higher.	Low—cutting is done with simple tools.	Wide range—good for small lots as well as large quantities.
Cut Extrusions	High—usually over 20¢ per lb.	Low—cutting is done with simple tools.	Wide range—useful for large and small quantities.
Impact Extrusions	Moderate—mostly used for aluminum, zinc, lead.	Medium—dies often cost less than $100.	Wide range—quantities can vary from thousands to millions.
Welded or Brazed Assemblies	Low cost materials can be used (carbon, steel, etc.).	Low to moderate—assembly jigs sometimes required.	Small quantities best, although small assemblies can be mass produced at low cost.
Molded Plastics	Medium to high — material varies from 10 to 15¢ per lb. to over $1.00 per lb.	Medium to high — depending upon type of mold or die required; from $100 up, generally.	Large lots—over 5,000 pieces best.
Molded Nonmetallic	Moderate to high.	Medium — molds are often rather simple.	Wide—because of need for parts of some materials, quantities must be low.

tained and then making further study to reach a final decision.

Probably no one method or fabricated form is ideal to the extent that it offers everything that is desired. Compromises are often necessary, so it is up to those selecting methods to balance the limitations of any method against the advantages from the viewpoint of his particular product.

The data appearing in the following table are necessary brief, but sufficiently detailed to enable the reader to see for certain whether or not a given form would seem to offer the characteristics he needs.

No attempt has been made to spotlight any outstanding good point or shortcoming of the various forms, since in either case the characteristic may be an advantage at one time and a limitation at another.

Tabular data cover the following seven pages:

Cost Factors (continued)

Direct Labor Costs	Finishing Costs	Scrap Loss
High—men needed to mold, melt, shakeout, clean, etc.	Machining costs high, as are some cleaning and snagging operations.	Moderate—foundry scrap can be remelted, but machining chips are waste.
Medium.	Low to moderate, as little machining allowance is necessary.	Low—most scrap reusable in other castings.
High—process requires many skilled operators.	Low—little machining required.	Low—chiefly casting scrap, some of which can be reused.
Medium to low.	Low—little, if any, machining required.	Low—only gates, sprues, etc., which are remeltable.
High.	Low—machining not generally necessary.	Low—most casting sprues, gates, etc., are reusable.
Medium—skilled labor needed for heating, hammer work and finishing.	Medium—ferrous forgings require more finishing than nonferrous due to scale formation.	Medium—depending upon size and shape of part and machining requirements.
Medium, but less than drop forging.	Medium—same conditions as with drop forgings.	Medium—usually somewhat less than with drop forgings.
Medium—lowest of forging processes.	Medium, but often less than with other forging methods, *e.g.*, some holes are pierced.	Medium—often less than with other forging processes.
Low—process is almost entirely automatic.	Low—thread grinding or rolling sometimes needed.	Low—practically no scrap.
Medium—depending upon part size and shape.	Low—seldom necessary to do anything but clean and possibly trim.	Low to moderate—scrap from blanks can often be used to make smaller parts.
High—skilled craftsmen required.	Low—cleaning almost only requirement.	Moderate—in cutting blanks from sheet or strip.
Low—operations automatic and one operator can watch several machines.	Low—burnishing or cleaning might be necessary.	High—considerable material lost in form of chips in machining.
Moderate—some skilled help required for blending, sintering, resizing, etc.	Low—machining is difficult but seldom needed.	Low—virtually no waste material.
Medium to high—both skilled and semiskilled labor needed.	Low—parts require no subsequent finishing.	Little or no scrap.
Low—skilled labor not required.	Low generally—unless considerable machining is required.	Low.
Low—skilled labor not required.	Low—tumbling or deburring may be required.	Low—waste material removed at mill.
Low—little skilled labor needed.	Low—may require no finishing.	Low—little waste except blanking scrap.
Medium to high—skilled labor required.	Medium—joints must be cleaned.	Low.
Low—most operations are automatic.	Low—tumbling often used to remove fins and flash.	Medium to low, depending on process and material. Thermoplastic materials are reusable.
Moderate—few materials can be handled automatically.	Low.	Low.

Production and Design Factors

Part 1—Castings and Forgings

	Sand Castings	Permanent Mold Castings	Plaster Mold Castings	Die Castings	Precision Castings	Drop Forgings	Press Forgings	Upset Forgings	Cold Headed Parts	Stampings, Formed Parts
Choice of Materials	Wide. Ferrous, nonferrous, light and heavy metals cast.	Wide. Aluminum, magnesium, bronze, gray iron used chiefly.	Narrow. Limited to certain brasses, bronzes and aluminum alloys.	Narrow. Zinc, aluminum, magnesium, brass, tin and lead.	Extremely wide, including alloys difficult to forge or machine.	Medium. Ferrous and nonferrous parts are forgeable to varying degrees.	Medium. Most favorable to nonferrous metals.	Medium. Many ferrous and nonferrous materials.	Narrow. Confined to steel and highly ductile metals.	Wide. Includes all workable sheet metals.
Complexity of Part	Considerable complexity possible, including holes, bosses, locating pads, etc.	Limited. Mold and lack of pressure feeding controlling factors.	Great complexity possible. Mold destroyed after casting.	Limited only by die, which can be quite complex.	Extreme complexity possible. Mold destroyed after casting.	Limited by die. Undercuts possible with split dies.	Limited. Although permitting more complex shapes than drop forgings.	Limited to cylindrical shapes and certain dimensional ratios.	Limited. Less flexibility than forging.	Limited to shapes formed from sheet metal —many restrictive design rules.
Maximum Size	Huge parts can be sand cast—as large or larger than by any other method.	Practical limit is under 50 lb. (aluminum). Centrifugal castings can be larger than static.	Up to 15 lb. in most materials.	About 35 lb. for zinc, 18 to 20 lb. for light metals.	Large sizes possible, although under 2 lb. offers best possibilities.	Very large. Board hammer max. is 15 lb.; steam hammer good for larger sizes.	25 to 30 lb. a practical maximum, although larger forgings are produced.	Medium to large. 9-in. bar about the largest size. Weights may be high.	Small. 7 in. long by ½-in. dia. usual maximum.	Almost unlimited. Good method for very large parts, if design will permit.
Minimum Size	⅛ in. the minimum practical section thickness.	About 1 oz. Sections as thin as 0.1 in. often cast; 0.60 in. rarely.	Small, thin-sectioned pieces (down to 0.032 in.) practical.	Tiny fractions of an oz. Sections may be 0.012 to 0.015 in. for zinc, 0.035 to 0.050 for other alloys.	Extremely small, with sections down to 0.032 in.	Small. Fractions of an oz. Board hammer used for small parts.	Small. Fractions of an oz.; usually preferred over drop forging for smallest parts.	Small. Although not comparable to various casting methods for thinness of section.	Small. ⅛-in. dia. parts can be made.	Small. Sections as thin as 0.003 to 0.005 in. possible.
Mechanical Properties	Fair to high.	Fair. (Good for centrifugal castings).	Fair	Fair to good.	Good	High	High	High	High	Fair to high.
Precision and Tolerances	Low. ±1/32 in. commercial tolerances.	High. ±0.0015 to 0.010 in.	Good. ±0.0005 to 0.010 in.	High. ±0.001 to 0.003 in. regularly met.	High. ±0.002 to 0.005 in. common; closer possible.	Medium. ±0.010 to ±0.030 in. tolerances are normal. 0.004 in. or better possible by coining at extra cost.	Medium. Somewhat better than drop forging.	Medium. Similar to press forging.	High. ±0.002 in. possible; ±0.010 in. common.	High. ±0.001 in. is common and closer tolerances are possible on smaller parts.

Special Structural Characteristics	Good bearing structure.	Centrifugal castings have high strength and density.	None	Inserts of other metals can be cast in.	None	Grain flow provides toughness.	Hot-worked structure a mechanical advantage.	Grain flow provides toughness.	Grain flow adds to toughness.	None
Surface Smoothness	Poor	Good. Often obviates finishing.	High	Good. Often obviates finishing.	Excellent	Medium	Medium	Medium	High	High
Surface Detail	Fair	Fair. Better if centrifugal.	Good	Good	Accurate reproduction of surface detail possible.	Medium. Some detail reproducible.	Medium. Some reproducible detail.	Medium	Fair	Fair
Getting into Production	Moderate speed. 3 to 15 days for pattern.	Several days to a few weeks.	Several days to a few weeks.	Several days to a few weeks.	Fast. Sometimes in a few hours using a sample part as a master.	Slow. One to several weeks needed to make dies.	Slow. Somewhat faster than drop forging.	Slow. Similar to drop forging.	Fair. Dies are relatively simple.	Slow. Die design and production may take several days to weeks.
Rate of Output	25 to 600 or more per hr. (using match plates and high-speed molding machines).	Moderate. Up to 100 per hr. customary—sometimes higher.	Fast. Up to 1,000 per hr., depending on size.	High. Usual range 100 to 1,000 per hr.; sometimes as high as 3,000.	Slow. Up to 100 per hr.	Medium. 120 per hr. is possible with small parts. 40 per hr. typical for moderate parts.	Medium. Slower than drop forging.	Medium. Equal to or better than drop forging.	High. 4,800 per hr. common, with much higher production possible.	High. Up to several thousand pieces per hr.
Remarks	Sand cast parts usually require machining to final size, at least on some sections.	Permanent mold castings fall somewhere between sand castings and die castings as far as complexity, tolerances, cost and production rates are concerned.	Although molding costs are greater than for sand casting, savings can result from the better finish attained.	Die castings are among the most economical metal forms, as production is high, finishes good and tolerances fine.	Precision casting is suited to production of parts too intricate for sand casting or powder metallurgy and made of materials that cannot be die cast.	Drop forging is generally regarded as a process to be used when high strength and high production are involved. Die costs limit use somewhat. Drop forging is usually preferred over other forging methods when large pieces are produced.	Offer somewhat closer tolerances than drop forgings, and permit somewhat greater design intricacy.	Upset forgings are made from bar stock to dimensions equivalent to press forgings. Small parts are best suited to this production method.	This form of upset-forging is used for many parts of the type generally produced on screw machines. Used principally for simple flanged or headed products such as bolts, screws, etc.	Pressed metal parts are usually the cheapest, when quantities are high, since materials costs are low and production fast; only method for extremely thin sections.

Continued on page 80 for other fabricated materials and forms

Production and Design Factors

Part II—Miscellaneous Formed Parts

	Spinnings	Screw Machine Parts	Powder Metal Parts	Electroformed Parts	Sectioned Tubing	Cut Extrusions	Impact Extrusions	Welded or Brazed Assemblies	Molded Plastics	Molded Nonmetallics
Choice of Materials	Wide. Many sheet metals, including stainless steel, nickel alloy, light metals, etc., are spinnable.	Wide, although materials with high machinability rating are most frequently used—steel, brass, aluminum, magnesium.	Narrow for mechanical parts. (Iron, iron-copper, copper, bronze, brass, steel.)	Narrow. Limited to iron, copper, nickel and chromium.	Wide. Steels, stainless steels, all ductile nonferrous metals, plastics, hard rubber.	Narrow. Copper alloys, aluminum, magnesium most popular. (New processes now in development will permit extruding of mild steels in restricted shapes.)	Narrow. Aluminum, lead, copper, soft metals best.	Wide. Dissimilar metals can be assembled into one product.	Wide range of plastics available offering many different characteristics.	Natural and synthetic rubbers, silicones, technical ceramics, glass and mica compositions, inorganic plastics, carbon, graphite.
Complexity of Part	Limited to cylindrical, circular or concentric shapes.	Limited to rotational shapes, although cross holes and under-cuts are easily made.	Limited by die, poor flow of powders, and by difficulty of transmitting pressures thru great depths of powders.	Designs of extreme complexity are possible.	Limited by sectional shapes of available tubing.	Can be complex in cross-section, but uniform in section along length.	Limited generally to shell-like shapes and derivations.	Complex and intricate forms can be produced by these methods.	Limited by die, although some side coring is possible.	Limited by dies.
Maximum Size	Large. Spinnings several feet in dia. are easily made. Max. gages are about ¼ in. for soft metals down to ⅛ in. for stainless.	Medium. Most machines handle stock up to 2½ in. in dia. and 6 in. long, although newer machines have capacities up to 8-in. dia.	Small parts up to 4 sq. in. section are best, although bearings of considerably greater size have been made.	Overall size limited by capacity of available plating equipment. Section thickness up to ½ in. possible.	Usually 4- to 6-in. O.D. max., but larger sizes up to 12 in. or even 22 in. available in some welded tubing.	Medium. 8- or 10-in. dia. is the usual maximum.	Large, although limited by press capacity. Common large size is about 4-in. dia. by 12-in. length.	Structures of unlimited size are possible.	Small parts—under 2 lb.—best, although larger and heavier parts can now be made.	Small parts best suited, including cylinders up to 6-in. I.D.
Minimum Size	Spinnings ¼-in. dia. in gages less than 0.040 in. are made.	Extremely small. Often under 1/16-in. dia. and weighing fractions of an ounce.	Very small. Parts smaller than 1/16 in. in dia. of width can be made.	Sections as small as 0.005 in., or less, are possible.	In ordinary metal tubing the smallest O.D. is about ¼ in., although specialty tubing as small as 0.012 in. is made.	Very small. 0.050-in. sections possible with aluminum and magnesium.	Small. Fractions of an ounce. Walls can be as thin as 0.003 in.	Usually not very small, although thin and thick sections can be combined in the same design.	Small. 1/32-in. thickness is a common minimum.	Fairly small, but depending upon hardness of composition being molded.
Mechanical Properties	Good. Strong materials can be used and the process cold works them.	High. Strong materials most commonly used.	Fair to good. Impact values are low, wear resistance high, tensiles higher than formerly.	Fair. Somewhat lower than wrought stock.	Good. Cold working provides extra strength; strong alloys available.	Good. Aluminum and magnesium alloys can be heat treated. Strong brasses and bronzes used.	High. Parts are cold-worked. Aluminum alloys can be heat treated.	Usually good, but depends on properties of components.	Low. Invariably lower than metal parts for similar uses.	Low, as compared to metals.
Precision and Tolerances	Fair. ±0.015 to 0.060 in. are commercial tolerances; ±0.005 in. available at extra cost.	High. ±0.0005 to 0.001 in. possible; ±0.001 to 0.003 in. customary.	High. ±0.0005 in. obtained by sizing, ±0.001 to 0.005 in. common.	High. ±0.002 to 0.0002 in. regularly met.	Good. Small sizes can be held to ±0.002 in., larger sizes to ±0.004 to 0.025 in.	Fair. ±0.005 to 0.020 in. is common on widths for aluminum and ±0.005 and wider for copper alloys.	High. Tolerances closer than 0.001 in. are common.	Medium. Depends upon precision of component parts; joints are seldom closer than ±0.020 in.	High. ±0.005 in. are commercial tolerances. Can be held to ±0.002 in. Transfer molding most precise.	Many such materials can be produced to accuracies of ±0.002 in., commercially, with ±0.001 in. possible.

	±0.005 in. available at extra cost.	to 0.005 in. customary.	to 0.005 in. common.		±0.004 to 0.025 in.	aluminum and ±0.005 and wider for copper alloys.		parts; joints are seldom closer than ±0.020 in.	±0.002 in. Transfer molding most precise.	±0.002 in., commercially, with ±0.001 in. possible.
Special Structural Characteristics	Grain flow improves properties somewhat.	None	Many possible structures. Regulated porosity, duplex materials, incorporation of nonmetallics possible.	Extremely dense structures possible. Laminations of different metals can be attained.	Grain flow improves properties of extruded tubing.	Grain flow improves properties somewhat.	Grain flow improves properties somewhat.	Powder metal parts or other special-structure components can be joined.	Inserts, metal inlays, and various combinations with fillers, etc., are possible.	None
Surface Smoothness	Good. Surface finish often excellent and spun shapes attractive.	Excellent. Surfaces are smooth and lustrous.	Fair. Depends upon porosity.	Excellent. High finish obtained without additional operations.	Good	Good	Good	Depend entirely upon component parts.	Excellent. Interesting and novel colors and effects can be obtained.	Fair to excellent, depending upon material being formed.
Surface Detail	None possible by this method.	Good. Knurling and fine serrations readily made.	Fair. Some detail can be registered on suitable surfaces.	Excellent. Minute and intricate surface patterns readily reproduced.	None possible by this method.	Only as part of extruded contour.	Good, if required.	None possible in the joining process.	Good. Markings, etc., readily reproduced, especially if depressed rather than raised.	Fair on such materials as hard rubber, ceramics and cold mold plastics; poor on most others.
Getting Into Production	Quick. Forms can be made in a short time, and can be changed readily in a short time.	Moderately fast. Tool engineering, cam making and set-up may take a few days.	Medium. Dies must be carefully designed and made of hard-to-machine materials. Set-up time 1 to 30 hr.	Master, or die, may take several weeks to prepare. Plating set-up fast.	Fast. Most standard round or rectangular tubing can be delivered from stock.	Quickly, after shapes are in stock. If shape is special it may require some time to get extrusions.	Fair. Dies can be obtained in a few days.	Fair. Can be fast once design and method are determined.	Slow. Weeks usually required to make dies for a new design.	Fair. Dies vary from simple to complex.
Rate of Production	Slow. 12 to 30 per hr. covers many jobs.	Extremely high. Up to 3,000 to 4,000 per hr. on small parts.	High. 1,800 per hr. is not uncommon. Under ideal circumstances output can be several thousand per hr.	Slow. Time required usually figured in days.	High. Parts are often turned out in automatic machinery.	High. 1,000 small parts per hr. possible on automatic lathes, or saws.	High. Small parts can be produced faster than 2,000 per hr.	Varies over a wide range, but usually on low to medium side. Furnace brazing and resistance welding are often fairly rapid.	Medium. 20 to 60 shots per hr. average; 300 shots per hr. about max. Multiple cavity molds can increase number of parts produced.	Slow, with some exceptions. Most of materials listed require slow curing or other processing after forming.
Remarks	Overall costs, particularly on large pieces, is considerably less than by any other forming method.	When part and material lend themselves to this process, it is the fastest, cheapest and most accurate.	Powder metallurgy parts can be made of materials not formable by any other means.	Finds best application in cases where extreme accuracy of surface detail is essential.	When shape of parts permit, tubing can often reduce material costs appreciably through reduction in scrap losses.	In addition to providing final shapes, extrusions are also used in some materials to reduce forging costs by providing blanks close to final shape.	Although most impact extrusions are used for containers, considerable quantities are used as shells, cylinders, shields and similar parts in electrical and electronic applications.	Many design requirements can be met only through the use of welding or brazing two or more metal forms into one assembly.	Molded plastic parts often serve as alternatives for metal forms with many definite advantages, including lower costs and elimination of many finishing operations	All of the materials listed have desirable characteristics for certain applications; thus speed of production and cost are of minor importance.

Materials and Corresponding Forms for Small Parts

Material	Physical Properties				Atmospheric Corrosion Resistance	Forms in Which Commonly Used for Fabricated Parts
	Melting Points, Deg. F	Specific Gravity	Tensile Strength, Psi.	Yield Strength, Psi.		
Low Carbon Steel and Iron	2750-2800	7.8-7.9	50,000-120,000	30,000-90,000	Fair	1, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18
High Carbon Steels	2600-2750	7.8	100,000-200,000	75,000-175,000	Fair	1, 5, 9, 10, 12, 15, 18
Engineering Alloy Steels	2500-2750	7.8-8.8	80,000-250,000	50,000-210,000	Fair	1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 18
Tool and Die Steels	2600-2800	7.5-10.0	100,000-250,000	80,000-200,000	Good	1, 5, 6, 15, 18
Tungsten Carbide	Cobalt melts 2700	14-15	125,000-400,000 transverse rupture strength		Good	13, 18
Stainless Steels	2500-2800	7.4-8.0	100,000-220,000	50,000-125,000	Excellent	1, 5, 6, 7, 8, 9, 10, 11, 12, 18
Tinplate	Tin melts 450	8 approx.	50,000-60,000	25,000-30,000	Excellent	10, 11, 13, 15, 18
Iron, Cast and Malleable	2100-2400	7 approx.	25,000-120,000	Up to 60,000	Fair	1, 2, 10, 13, 14, 18
Copper	1980	8.9	23,000-52,000	14,000-50,000	Good	1, 6, 7, 8, 10, 11, 13, 14, 15, 16, 17, 18
Bronzes	1800-1950	7-9	40,000-200,000	20,000-175,000	Good	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18
Brasses	1720-1950	8.4-8.8	30,000-40,000	15,000-50,000	Good	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18
Nickel-Base Alloys	2200-2600	8.3-8.9	60,000-100,000	30,000-80,000	Excellent	1, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 18
Noble Metals (Inc. Silver)	1750-3600	10-21.5	23,000-150,000	12,000-80,000	Excellent	5, 9, 10, 11, 12, 13, 15, 17, 18
Zinc and Its Alloys	727-785	6.6-7.1	15,000-45,000	10,000-25,000	Good	2, 4, 10, 11, 12, 17, 18
Lead and Its Alloys	300-625	10.5-11.5	2,000-12,000	1,000-10,000	Good	4, 15, 16, 17, 18
Tin Alloys	360-470	7.3-7.8	2,000-15,000	1,300-9,800	Good	4, 11, 15, 18
Aluminum and Its Alloys	940-1225	2.6-2.9	13,000-72,000	5,000-62,000	Good	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18
Magnesium Alloys	815-1200	1.74-1.9	13,000-65,000	3,000-50,000	Fair	1, 2, 4, 6, 7, 8, 13, 15, 16, 17, 18
Silicones	Usable up to 390	1.3-2.3	400-600	—	Excellent	16, 20
Ceramics, Technical	Working temp. below 1832-3112	1.6-4.0	3,000-10,000	—	Excellent	16, 20
Rubber, Natural	Working temp. below 212	0.93-2.00	3,000-4,500	—	Fair	16, 20
Rubber, Synthetic	Soften between 225-300	1.20	1,400-4,550	—	Good	16, 20
Plastics	Working temp. below 475	1.25-2.09	3,000-15,000	—	Excellent	16, 19

Materials Engineering File Facts

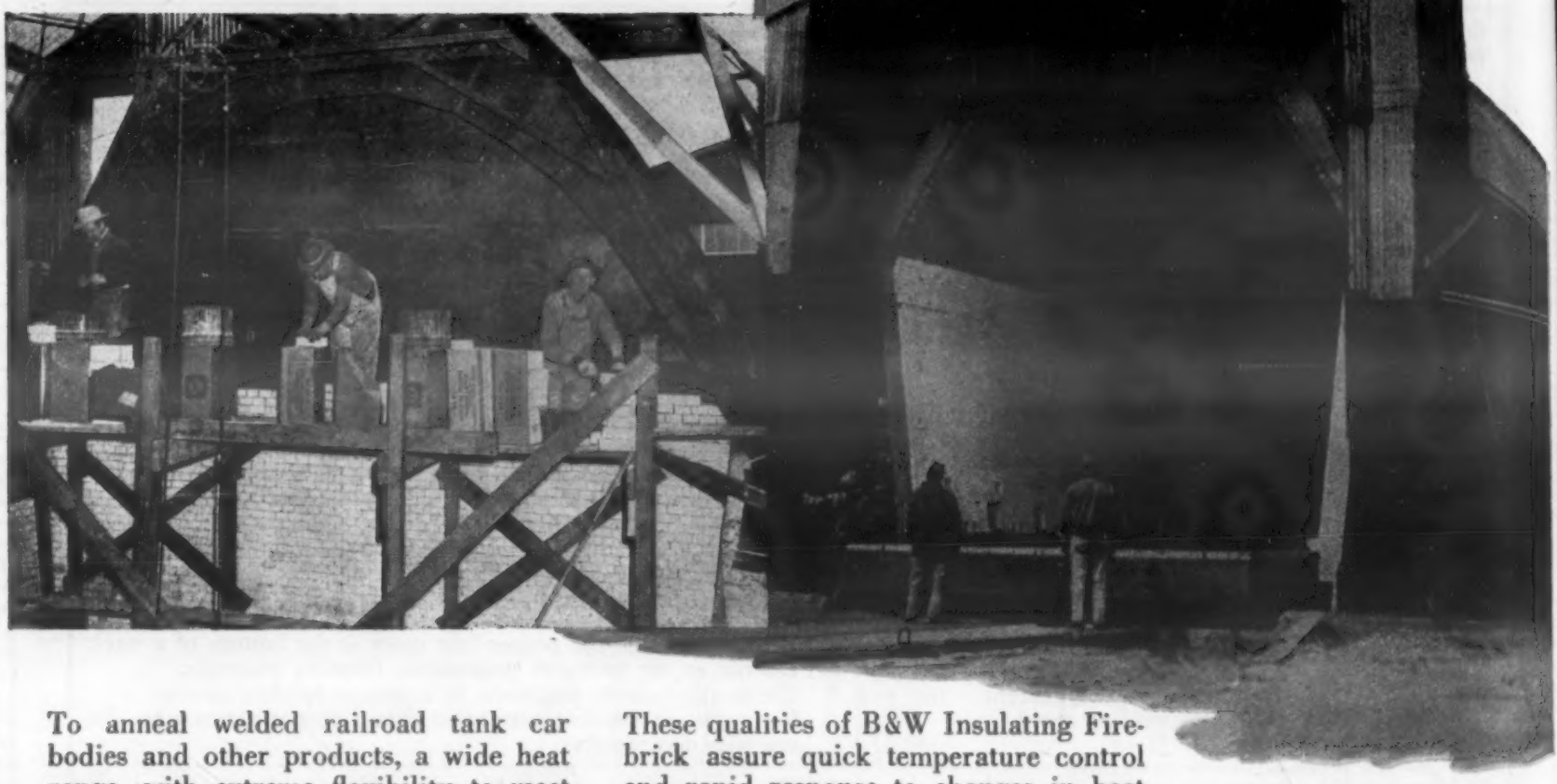
NUMBER 184
December, 1949

Causes and Cures of Common Welding Problems

Problem	Cause	Cure
Cracked Welds	1. Joint too rigid. 2. Welds too small for size of parts joined. 3. Poor welds. 4. Improper preparation of joints. 5. Improper electrode.	1. Design the structure and develop a welding procedure to eliminate rigid joints. 2. Do not use too small a weld between heavy plates. Increase the size of welds. 3. Do not make welds in string beads. Make welds full size in short section 8 to 10 in. long. 4. Welding sequence should be such as to leave ends free to move as long as possible. 5. Insure that welds are sound and the fusion is good. 6. Preheating parts to be welded is sometimes helpful. 7. Prepare joints with a uniform and proper free space. In some cases, a free space is essential. In other cases, a shrink or press fit may be required.
Brittle Joints	1. Air hardening base metal. 2. Improper preheating. 3. Unsatisfactory electrode.	1. When welding on medium carbon steel or certain alloy steels, the heat-affected zone may become hard as a result of rapid cooling. Preheating at 300 to 500 F should be resorted to before welding. 2. Multiple layer welds will tend to anneal hard zones. 3. Annealing at 1100 to 1200 F should be done after welding and will generally soften hard areas formed during welding. 4. The use of austenitic electrodes is sometimes desirable on steels which harden readily. Increased weld ductility compensates for the brittle, heat-affected area in the base metal.
Incomplete Penetration	1. Improper preparation of joint. 2. Use of too large an electrode. 3. Insufficient welding current. 4. Too fast a welding speed.	1. Be sure to allow the proper free space at the bottom of a weld. 2. Do not expect excessive penetration from an electrode. 3. Use small diameter electrodes in a narrow welding groove. 4. Use sufficient welding current to obtain proper penetration. Do not weld too rapidly.
Welding Stresses	1. Joints too rigid. 2. Improper welding sequence. 3. Inherent in all welds, especially in heavy parts.	1. Slight movement of parts during welding will reduce welding stresses. 2. Make weld in as few passes as practical. 3. Peen each deposit of weld metal. 4. Anneal finished product at 1100 to 1200 F for 1 hr. per in. of thickness. 5. Develop welding procedure that permits all parts to be free to move as long as possible.
Porous Welds	1. Inherent property of some electrodes. 2. Not sufficient puddling time to allow entrapped gas to escape. 3. Poor base metal. 4. Too short an arc length.	1. Some electrodes inherently produce sounder welds than others. Be sure the proper electrodes are used. 2. Puddling keeps the weld metal molten longer and often insures sounder welds. 3. Do not use excessive welding currents. 4. A weld made of a series of strung beads is apt to contain minute pin holes. Weaving will often eliminate this trouble. 5. In some cases, the base metal may be at fault. Check this for segregations and impurities. 6. Do not hold too short an arc.
Arc Blow	1. Magnetic fields cause the arc to blow away from the point at which it is directed. Magnetic blow is particularly noticeable with d.c. at ends of joints and in corners.	1. Proper location of the ground on the work. Placing the ground in the direction the arc blows from the point of welding is often helpful. 2. Separating the ground in two or more parts is helpful. 3. Weld toward the direction the arc blows. 4. Hold a short arc. 5. Change magnetic path around arc by using steel blocks. 6. Use a.c. welding.
Irregular Quality	1. Improper electrode manipulation. 2. Excessive welding current. 3. Welding in improper position for which electrode is designed. 4. Improper joint design.	1. Use a uniform weave or rate of travel at all times. 2. Do not use excessive welding currents. 3. Use an electrode designed for the type of weld and the position in which the weld is to be made. 4. Prepare all joints properly.

(Continued on page 85)

B&W IFB help anneal tank cars, too!



To anneal welded railroad tank car bodies and other products, a wide heat range, with extreme flexibility to meet complicated heat treating problems, was an important requirement in this large furnace designed and built by **JET COMBUSTION, INC.** for General American Transportation Corporation.

B&W IFB — which have the lightest weight, lowest heat loss, and the lowest heat storage of all insulating firebrick — were selected for the furnace lining.

These qualities of B&W Insulating Firebrick assure quick temperature control and rapid response to changes in heat input. Then, too, their extra light weight saves on furnace construction costs, simplifies furnace design.

Whether your furnace is large or small, you will benefit by using economical B&W Refractories. Why not talk it over with your local B&W Refractories Engineer. Just telephone or drop him a postcard today.

FURNACE SPECIFICATIONS

Inside length	52'
Inside width	19'
Car top to arch	21'
Arch Span	21'

Walls of B&W K-23 IFB
Arch of B&W K-26 IFB

R-359

B&W REFRACTORIES PRODUCTS

B&W 80 FIREBRICK • B&W JUNIOR FIREBRICK
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Materials Engineering File Facts

NUMBER 184—(Continued) CAUSES AND CURES OF COMMON WELDING PROBLEMS

Problem	Cause	Cure
Poor Surface Appearance	1. Improper current and arc voltage. 2. Overheated work. 3. Poor electrode manipulation. 4. Inherent characteristics of electrode used.	1. Insure the use of the proper welding technique for the electrode used. 2. Avoid excessive welding currents. 3. Use a uniform weave or rate of travel at all times. 4. Select proper electrode.
Undercutting	1. Excessive welding current. 2. Improper manipulation of electrode. 3. Attempting to weld in a position for which the electrode is not designed.	1. Use a moderate welding current and do not try to travel too rapidly. 2. Do not use too large an electrode. If the puddle of molten metal becomes too large, undercut may result. 3. Excessive weaving causes undercut, consequently should not be used. 4. A uniform weave will aid greatly in preventing undercut in butt welding. 5. If an electrode is held too near the vertical plane when making a horizontal fillet weld, undercut may be obtained on the vertical plate.
Splatter	1. Inherent property of some electrodes. 2. Excessive welding current for the type or diameter of electrode used. 3. Excessively long arc. 4. Arc blow.	1. Select proper type of electrode. 2. Do not use excessive welding current. 3. Hold proper arc length. 4. Reduce arc blow. 5. Paint parts adjacent to weld with whitewash. This prevents spalls from welding to parts and makes removal easy.
Warping (Thin Plates)	1. Shrinkage of deposited weld metal. 2. Excessive local heating at the joint. 3. Improper preparation of joint. 4. Improper clamping of parts.	1. Select electrode with high welding speed and moderate penetrating properties. 2. Weld rapidly to prevent excessive local heating of the plates adjacent to the weld. 3. Do not have excessive spaces between the parts to be welded. 4. Properly clamp parts adjacent to the joint. Use back-up to cool parts rapidly. 5. Use special welding sequence; step back or skip procedure. 6. Peen joint edges slightly before welding. This elongates edges and the weld shrinkage causes them to pull back to the original shape.
Corrosion	1. Type of electrode used. 2. Improper weld deposit for corrosive media. 3. Metallurgical effect of welding. 4. Improper cleaning of weld.	1. Bare-type electrodes produce welds that are less resistant to corrosion than the parent metal. 2. Shielded arc-type electrodes produce welds that are more resistant to corrosion than the parent metal. 3. Certain materials such as aluminum require careful cleaning of all slag to prevent corrosion. 4. Do not expect more from the weld than you do from the parent metal. On stainless steels use electrodes that are equal or better than the base metal. 5. When welding 18:8 austenitic stainless steel, be sure the analysis of the steel and electrode does not cause carbide precipitations. This condition can be corrected by annealing at 1900 to 2100 F.
Poor Fusion	1. Improper diameter of electrode. 2. Improper welding current. 3. Improper preparation of joint. 4. Improper welding speed.	1. When welding in narrow vees, use an electrode small enough to reach the bottom. 2. Use sufficient welding current to deposit the metal and penetrate into the plates. Heavier plates require higher current for a given electrode than light plates. 3. Be sure the weave is wide enough to melt thoroughly the sides of a joint. 4. The deposited metal should tend to sweat onto the plate and not curl away from it.
Distortion	1. Shrinkage of deposited metal pulls parts together and changes relative positions. 2. Improper welding sequence. 3. Nonuniform heating of parts during welding.	1. Properly clamp or tack parts to resist shrinkage. 2. Preform parts sufficiently to compensate for shrinkage of welds. 3. Study structure and develop a definite sequence of welding. 4. Distribute welding to prevent excessive local heating. Preheating desirable on some heavy structures. 5. Removal of rolling or forming strains before welding is sometimes helpful.

Adapted from material supplied by Westinghouse Electric Corp., Welding Department.

Another profitable conversion to Kaiser Aluminum 150S

QC (Quick Coupling) Metalbestos gas vent and flue pipe, made by Williams-Wallace Company, San Francisco, is a double wall pipe that assures maximum insulation, minimum heat loss, extremely high resistance to corrosion. It's made of Kaiser Aluminum, including unique die-formed, permanently attached couplers. Inside pipe is made of 2S—outside pipe is 150S. Approved by U. L. as a Type B gas vent.

Originally made of galvanized steel, later made of 52S, the outside wall of QC Metalbestos gas vent pipe is now made of the new Kaiser Aluminum Alloy 150S. Here's why:

Compared to galvanized steel—aluminum is much lighter, far more resistant to corrosive flue gases—and is extremely workable. Cost of the finished article is the same.

Compared to 52S—150S is more workable, too. And though it costs less, it doesn't sacrifice any of Kaiser Aluminum's light weight, freedom from rust and resistance to corrosion.

In addition, the workability and light weight of this remarkable new alloy saves steps in fabricating, handling, storing. Shipping costs are cut.

Customers like the permanent aluminum-bright finish of Metalbestos gas vent pipe—workers like the ease with which they can install it.

We'll gladly show you how 150S can benefit your operation—and show you other examples of profitable conversions to this new Kaiser Aluminum alloy.

Kaiser Aluminum is produced by Kaiser Aluminum & Chemical Corporation.

Kaiser Aluminum

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New Materials and Equipment

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Stainless Steel Now Welded by New Metallic Arc Process

Use of the Aircomatic or inert gas-shielded metallic arc welding process for the welding of stainless steel and aluminum bronze, in addition to aluminum, was announced recently by *Air Reduction Sales Co.*, 60 E. 42 St., New York 17.

In the Aircomatic process, a coiled wire electrode in a gaseous shield is fed continuously through the barrel of a welding gun which can be moved along the seam manually or automatically.

Applied to the welding of stainless, the process is claimed to have several specific advantages over the older methods. Whereas some alloying elements are almost completely lost in the transfer of filler metal in existing metal arc welding methods, it is claimed that virtually no losses occur in the new process. Even titanium is 60% transferred, and this makes feasible use of titanium-stabilized filler metal rather than columbium-stabilized filler.

The Aircomatic inert gas-shielded metallic arc process is now being used for welding stainless steel and aluminum bronze.

The Aircomatic process also deposits more stainless steel at the same welding current, thus minimizing heat effects in the base metal.

Physical properties of the welded joint are said to equal and sometimes exceed those achieved by other methods. The welds are without porosity or slag inclusion, and they can be ground, buffed and polished as easily as other welds.

High welding speeds are possible. Using 1/16-in. wire, deposition rates (downhand position) up to 15 lb. per hr. can be attained. The necessity of changing electrodes is eliminated, and there is no stub loss. Additional savings in overall fabrication costs are made possible because 3/8-in. thick square-edged plates can be welded without further edge preparation by putting in only two passes—one from each side.

Since only a fine wire must reach to the bottom of the weld groove and there is no slag to be trapped, the included angle can be reduced to about 30°; this saves material and time. Wire is available now in diameters of 0.035, 0.045 and 1/16 in., and in AISI types 310, 316 and 347.

Applied to aluminum bronze, this process has given porosity-free welds, difficult to obtain with the softer grades using coated stick electrodes.

Low Melting Alloy Announced for Precision Casting Patterns

A noneutectic alloy of bismuth and tin, having negligible shrinkage and a melting range of 281 to 338 F, has been introduced by *Cerro de Pasco Copper Corp.*, 40 Wall St., New York. The new alloy, named Cerrocast, has been found especially suitable for use in precision casting.

Because of its long melting range, Cerrocast can be readily coined to accurately reproduce the shape, dimensions and fine surface details of the master pattern. It also works satisfactorily in spray guns and for low-temperature soldering of pre-tinned metal parts.

Cerrocast has a yield temperature of 302 F, a density of 0.296 lb. per cu. in., Brinell hardness of 22, and shrinkage of 0.0001 in. per in.

New Materials and Equipment
(CONTINUED)

New Method Chemically Analyzes Stainless Steel in Two Minutes

A direct-reading method of analyzing stainless steels, claimed to be equal in accuracy to chemical analysis, has been developed in the *Applied Research Laboratories*, 4336 San Fernando Rd., Glendale 4, Calif.

Total time of analysis for all metallic elements is 2 to 3 min., including sample preparation. Duplicate analysis on a single sample for these constituents can be made in a total time of 3 to 4 min.

The equipment used in this method consists of the Laboratory's Two-Meter Spectrometer, a recording console and a Multisource.

Precision claimed for this system is higher than ever reported for any spectrochemical method. Tests on a variety of

High accuracy is reported for this new system of analyzing stainless steel.

rolled and cast samples have shown standard deviations from 0.3 to 0.4% of the quantity measured.

Good Machinability, Core Strength Claimed for New Hobbing Steel

Carpenter Steel Co., Reading, Pa., has announced a new steel for plastic mold cavities and force plugs which is said to offer excellent hobbing qualities plus good machinability and high core strength.

The steel, known as Samson Extra, has a type analysis as follows: 0.10 carbon, 0.30 manganese, 0.20 silicon, and 2.30% chromium. Average physical properties after case-hardening are listed below:

	Oil Quench	*Water Quench*
Case Hardness (Rockwell C)	64	65
Core Hardness (Rockwell C)	20	25
Core Tensile Strength	108,000	120,000
Core Yield Strength	69,000	91,000

Samson Extra is supplied to a maximum Brinell hardness of about 105. It is claimed that, with this new steel, many intricate mold shapes can be hobbed in one operation, deeper impressions can be pushed with present equipment, and more accurate reproduction of hob design is possible. Although Samson Extra is annealed for easiest hobbing properties, and is therefore soft, it machines easily because of its composition and controlled manufacture.

Cleanness, uniformity, wear resistance and finish of the hobbing steel are claimed to be high.

Magnesium Rectifier Developed for Use in Neutral Salt Baths

A new magnesium rectifier for neutral salt baths of calcium chloride composition has been developed by the *Upton Electric Furnace Co.*, Mount Clemens, Mich. The rectifier provides a safe, efficient and economical means for rectifying salt baths in built-in electrode type furnaces.

The new rectifier is made in the form of small round pellets composed of fine pieces of metallic magnesium in a matrix of calcium and sodium chlorides. These are thrown into the molten salt, where a quiet reaction takes place. The magnesium rectifier is claimed to (1) cut down on heat losses, (2) reduce fuming and loss of salts, (3) lower time for rectifying, (4) reduce sludge troubles, and (5) prevent decarburization or carburization of the work pieces.

Vehicles for Wrinkle Finishes Will Be Available in January

Three types of two standard vehicles used in the manufacture of Wrinkle Finishes will be available in January from *New Wrinkle, Inc.*, 1819 Bankers Bldg., Chicago, Ill.

The vehicles to be produced are: WV-101 S, based on a short oil oleo-resinous varnish; WV-201 L, a similar vehicle with increased oil lengths; and WV-301 A, an alkyd type. The manufacturer will need only to add dryers and pigments, then package the ready-to-use product.

The vehicles will be manufactured in a new pilot plant in Dayton, Ohio.

Improved Dimensional Stability Claimed for New Pattern Plastic

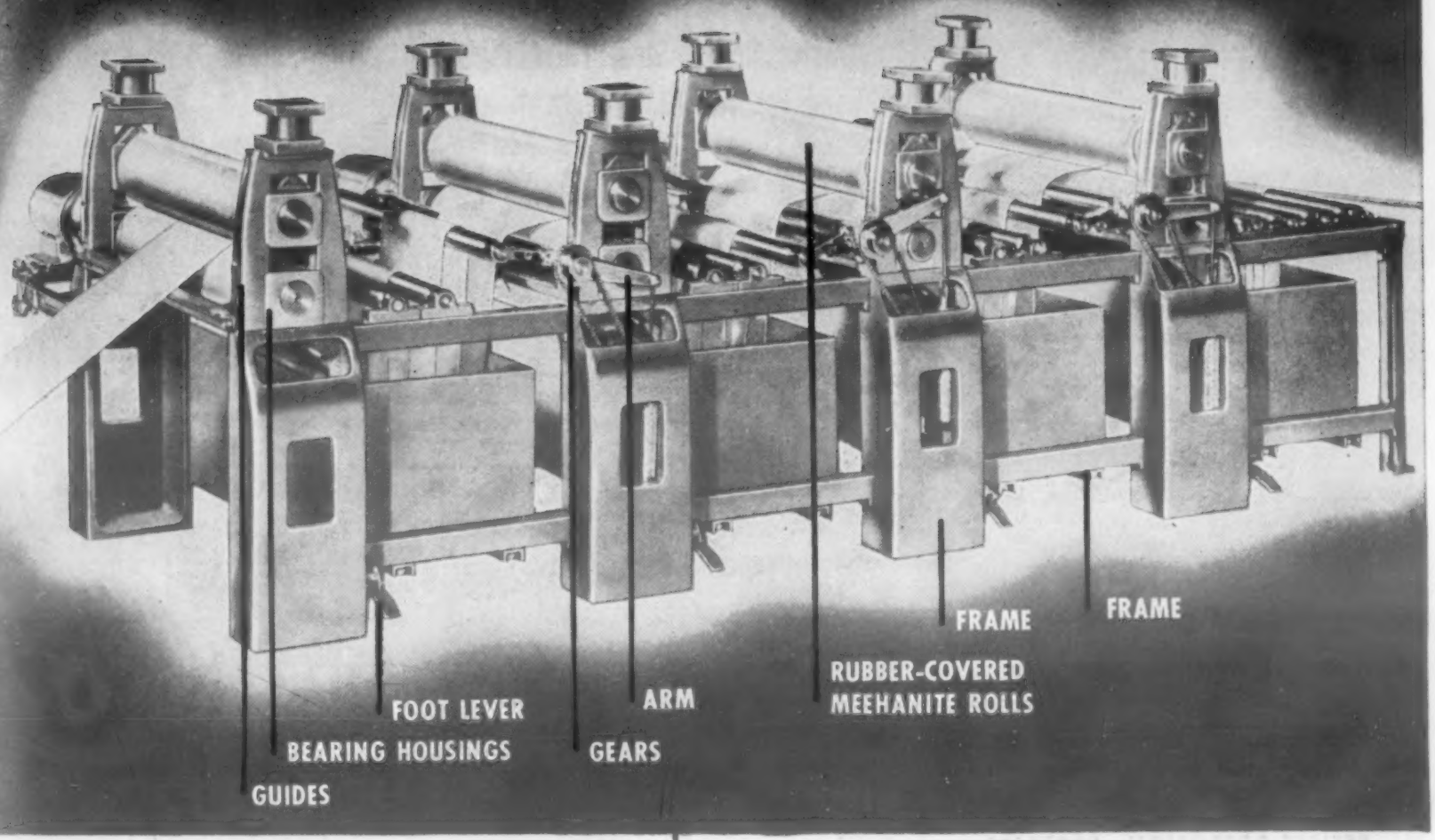
A new pattern plastic for use in precision casting has been developed by *A.R.D. Corp.*, 70 Pine St., New York 5. The plastic, known as Ard-Lustrex 15K, is said to offer better dimensional stability and easier handling of patterns, at a substantial saving in material cost.

Tests carried out on 15K have shown that it has about one-tenth the creep rate and one-seventh the deflection of pattern wax. Moreover, a study of volume expansion of 15K compared to commercial polystyrene reveals that the sudden increase in expansion rate, characteristic of normal molding plastics, is depressed to room temperature. Thus, during the critical temperture range of mold drying or during the initial stages of firing, 15K will expand at a uniform, lower rate than, for example, normal polystyrene.

Since 15K is a low pressure (1000 psi.) molding plastic, no great strength is required in the die. Casting alloys can therefore be used for molds, provided their melting points lie above 400 F. Molding temperature of 15K is about 350 F. Zinc base alloys are recommended for molds.

Low residual stresses in molded 15K make it possible to melt out the plastic before the thermal stress relief effect results in extensive warping and possible damage to the mold. This plastic can be melted out at 250 to 350 F, but firing at 800 F is recommended instead; when properly heated and fired, the 15K pattern leaves no ash.

MEEHANITE® Properties make this machine BETTER, STURDIER, FASTER



H. W. BUTTERWORTH & SONS CO., Philadelphia, are leading builders of a large line of textile industry equipment. Castings for their machinery are produced in their own Meehanite foundry. Their designers and engineers build in quality by utilizing from the beginning the better engineering characteristics available in the various types of Meehanite castings produced.

The photograph shows a Butterworth Compartment Washer and also indicates the variety of Meehanite castings used in every compartment.

To the equipment they provide higher vibration absorption properties; better strength characteristics; freedom from fear of hidden defects which might result in failure; in all,—a combination of those characteristics so important to builders of all types of equipment.

Write for Bulletin No. 32 entitled "Meehanite Quality Control Assures Uniform Dependability" to any of the foundries listed.

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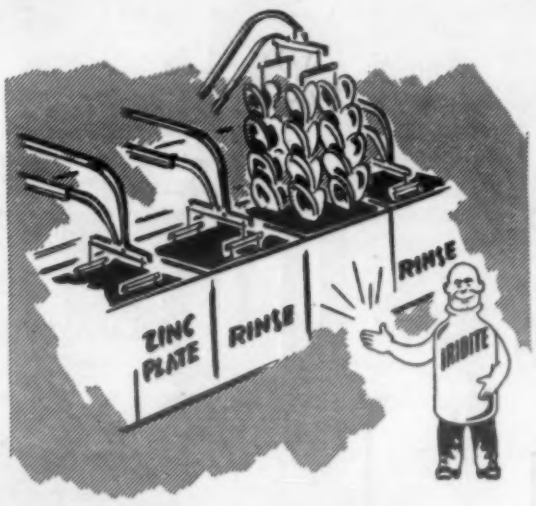


COMMON CHEMICAL ADDITION ELIMINATES CAUSTIC RINSE—PERMITS AMAZING LOW COST

The one-dip Iridite Bright treatment for standard automatic zinc plating machines has been proved successful and is now being used in product on runs.

RESISTS CORROSION—PROTECTS FROM STAIN

This amazingly low cost protective and brightening process produces a shining stain-free surface with good corrosion resistance . . . utilizing only the normal number of tanks after the zinc plating operation: rinse, Iridite, rinse.

SIMPLE TO OPERATE—NO BLEACHING DIP

This special one-dip Iridite Bright is a non-electrolytic chemical solution . . . operates at 80 to 85° F . . . with no specially trained personnel . . . equally adaptable to bulk plating of parts. Eliminates need for second or bleaching dip.

Whatever your problem in finishing zinc or cadmium — there's an Iridite to do the job. For details, write—wire—or 'phone.

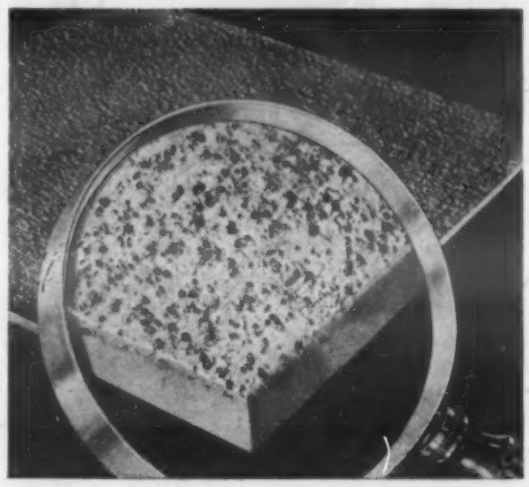
ALLIED RESEARCH PRODUCTS, INC.
4004 EAST MONUMENT STREET
BALTIMORE 5, MD.

New Materials and Equipment

Abrasive Rolled Steel Floor Plate Used for Non-Skid Applications

Abrasive rolled steel floor plate for non-skid applications is now available from *Alan Wood Steel Co.*, Dept. W-67, Conshohocken, Pa. The plate is being marketed under the trade name A. W. Algrip.

Designed for industrial floors, loading platforms and ramps, walkways, building entrances, trench and hatch covers, and many other applications. A. W. Algrip never loses its non-slip characteristics because, as the surface wears, new abrasive particles are exposed. The abrasive grain is rolled as an integral part of the upper portion of steel floor plate.



The magnifying glass reveals the even distribution of abrasive grain in A. W. Algrip Floor Plate.

The material can be sheared, drilled, countersunk, machined and flame-cut. Flanging is not recommended. Some forming is possible but requires special techniques.

The non-skid floor plates are available in thicknesses from ⅛ to ⅜ in., widths up to 60 in. maximum, and lengths to 144 in.

New Transformer Coil Material Promotes Higher Efficiencies

A new transformer core material, designated Ferroxcube III, is being used by *North American Philips Co.*, 100 E. 42 St., New York 17, to promote higher efficiency, more compact construction, and lower production costs for television and radio receiver chassis.

Ferroxcube III (described in MATERIALS

Free Folder!

--tells how to finish ZINC OR CADMIUM for better CORROSION RESISTANCE ...PAINT BASE

Eye Appeal

If your product uses zinc or cadmium in any form, find out now about Iridite . . . the chemical dip finishes that boost corrosion resistance . . . provide a paint base that defies peeling, flaking, chipping . . . brighten zinc, keeps it bright and free from stains. Write for details today . . . or better still, send samples of your product for FREE processing.

IRIDITE COATINGS *are used on--*

Washing Machine Parts • Radio Equipment
Kitchen Utensils • Aircraft Parts
Lock Hardware • Office Machines
Window Frames • Vending Machines
Wire Cloth • Tools
Lamp Fixtures • Fuel Pumps
Carburetors • Auto Hardware
Zinc Coated Sheet • Hinges, Screws, Bolts
Camera Parts • Plumbing Fixtures
Wall Panels • Refrigerator Parts
Wire Products • Instrument Parts
Electrical Equipment

ALLIED RESEARCH PRODUCTS, INC.
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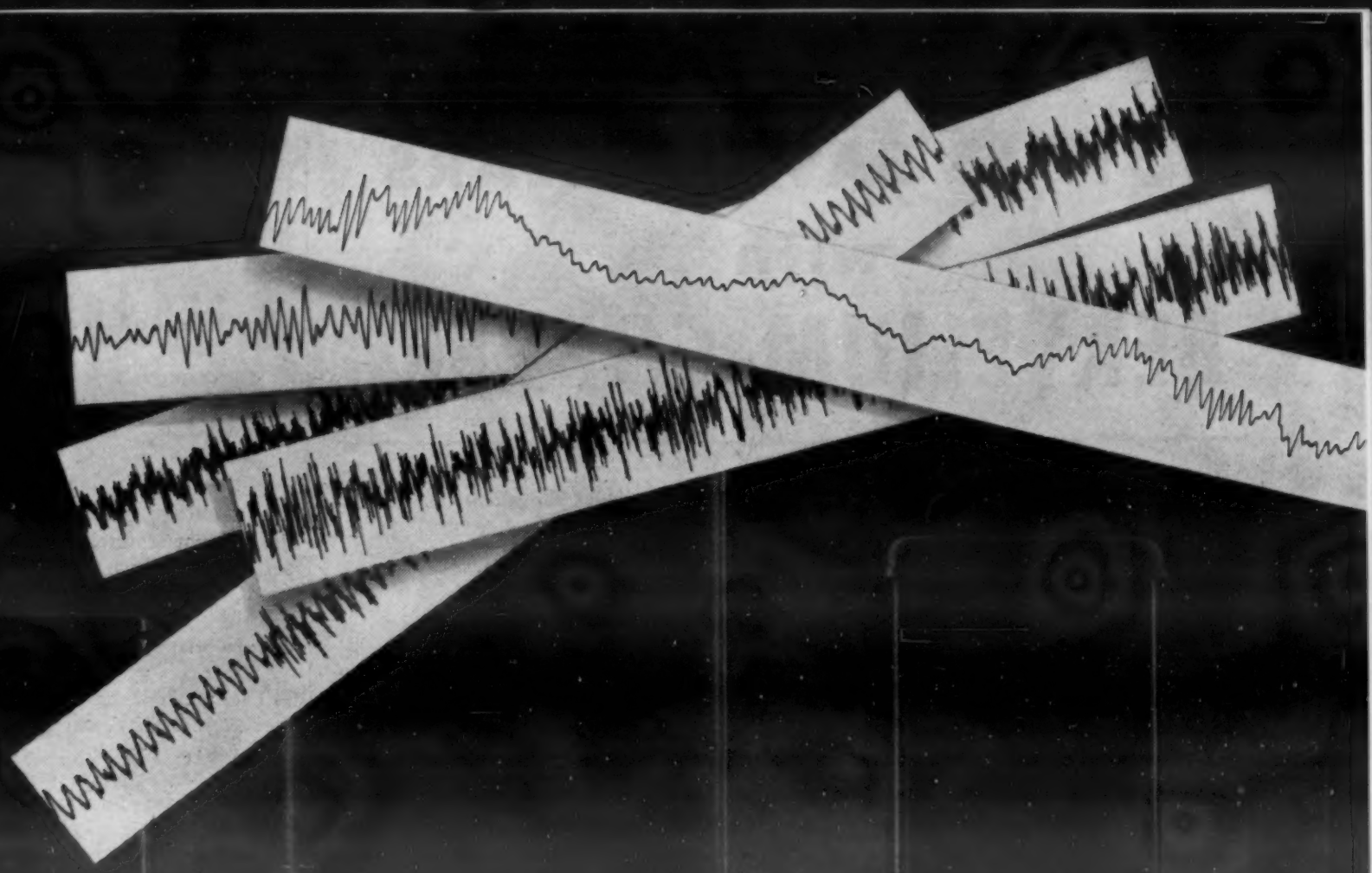


When you talk vibration— Photography clinches arguments

Photographic records of oscillograph traces which tell how electrical appliances are behaving—foretelling how well they'll sell and work and how long they'll last.

YES, you can put your finger right on some revealing peculiarity of a trace—take time to study it—discuss it with others. That is, if you make it a practice to record important oscillograph traces photographically. It's the sure way of getting the most value out of your oscillograph studies.

Two Kodak Linagraph Films are made especially for cathode-ray oscillograph work.

Kodak Linagraph Pan Film is the fastest film for the blue-emitting screens used for studying fast transients, and for the long persistence red-emitting screens.

Kodak Linagraph Ortho Film is for green-emitting screens.

In both of these you get the high density of line and the cleanness of background that give you maximum information from your traces. They are supplied in cassettes for 35mm. cameras and also in special 16mm. and 35mm. spoolings for several recording cameras.

For special cases where you need to record blue traces at the highest speed, you can get Kodak Tri-X Pan Plates, Type B.

Kodak Linagraph Films may be obtained from the Kodak Industrial Dealer in your area. Eastman Kodak Company, Rochester 4, N. Y.

Instrument Recording

—ANOTHER FUNCTION OF PHOTOGRAPHY

Kodak
TRADE-MARK

HOW to SAVE DOLLARS with BERYLLIUM-COPPER

Here is an opportunity to improve your product and—at the same time—cut costs. Valuable guides for the most economical use of age-hardening beryllium-copper, based on years of research and practical experience, are yours for the asking. Write TODAY for any or all of the following reprints.

Economies Result When Parts Are Designed for Beryllium-Copper

Case histories of successful designs where specific properties of beryllium-copper were used for best performance at lowest cost. ☐

Beryllium-Copper as a Spring Material

Technical data covering elastic strength, resistance to corrosion and fatigue, conductivity and other properties which make beryllium-copper ideally suited for spring design. ☐

Production of Metal Diaphragms

Helpful facts about beryllium-copper diaphragm design together with recommended tooling, heat-treating and testing procedures. ☐

How to Machine Beryllium-Copper

An up-to-date report summarizing current machining practice including proper tools, feeds, speeds and cutting fluids. ☐

How to Heat Treat Beryllium-Copper

Suggested techniques for low-cost heat-treating to meet specific property requirements without expensive equipment. ☐

In addition to the above literature, we have other data available. Or if you have a design problem, send us full information with a drawing or sample of the part.

BERYLCO BERYLLIUM

The **BERYLLIUM CORPORATION**

Dept. 6, Reading 3, Pa.

New Materials and Equipment

& METHODS, June 1949, p. 54) is a ferro-magnetic ferrite with unusually high permeability, high electrical resistivity, and good molding properties. It is now available in a number of standard shapes or in custom shapes to meet manufacturers' requirements.

The material has more than ten times the permeability of available powdered iron cores. This high permeability is of great advantage when the Ferroxcube structure is also designed to act as a magnetic shield. The electrical resistivity of the material, about 10 million times that of iron, results in sharply reduced eddy current losses.

These properties make Ferroxcube III useful in components such as horizontal output transformers of the type used in television receivers; in intermediate frequency transformers such as are used in superheterodyne circuits and in amplifier transformers for long-distance wire communication circuits; and in other circuits requiring low-loss inductors, coupling transformers and intermediate frequency transformers.

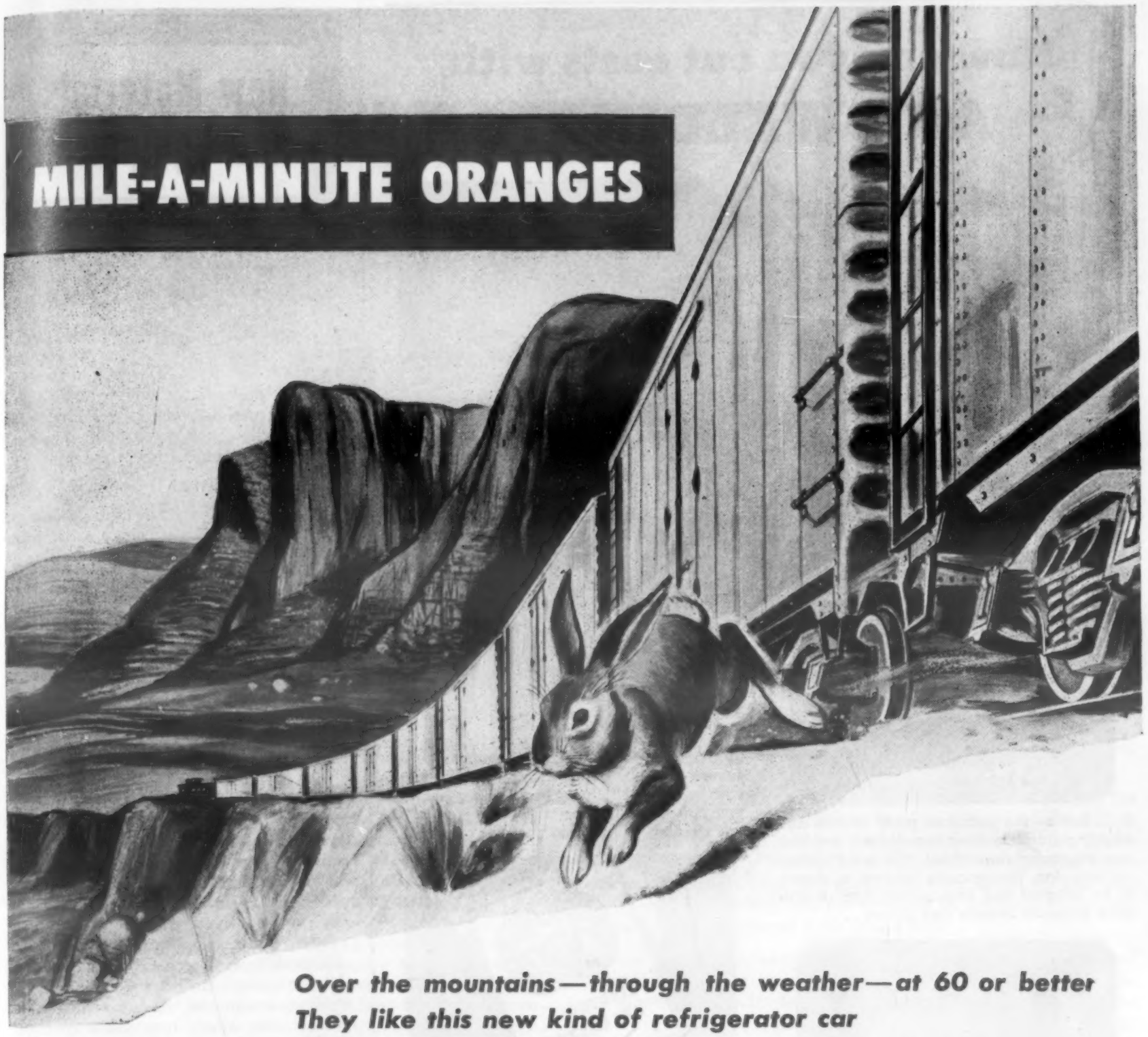
● A hydraulic, semi-automatic polishing machine for contour and flat work, such as hand tools, blanking stock and litho plate, has been announced by *Central Machine Works,* 72 Commercial St., Worcester, Mass. The new model, No. 5, has an 18-in. stroke and is claimed to effect considerable savings over present polishing methods.

Corrosion Resistant Alloys, New Welding Process Announced

New types of corrosion resistant steel alloys and a new welding method have been developed by *Uniworld Research Corp. of America,* 1302 Ontario St., Cleveland 13, Ohio.

Corrosion Resistant Steel Alloys

Chemical and acid resistance superior to that of stainless steel and the best known nickel-molybdenum alloys is claimed for a group of electro-steel alloys called Super Rustfree Steels or SRSteels. The SRSteels are said to stand up under the standard



Over the mountains—through the weather—at 60 or better
They like this new kind of refrigerator car
Because ALUMINUM LASTS

"Reefers on the high iron" is railroad lingo for refrigerator cars speeding your fresh fruits and vegetables over the main line. Because they highball, Alcoa Aluminum is ideal for these light weight cars. Means more payload. Less maintenance. And it is coming to mean something else—long service.

Alcoa built that into the metal.

In developing Alcoa Alloys, we learned to build strength into aluminum. We tested those alloys for fatigue and tensile strength. We proved them lasting, in corrosive industrial atmospheres, salt spray booths, and weather exposure. Then we were ready to say "Alcoa Aluminum lasts!"—and back it up.

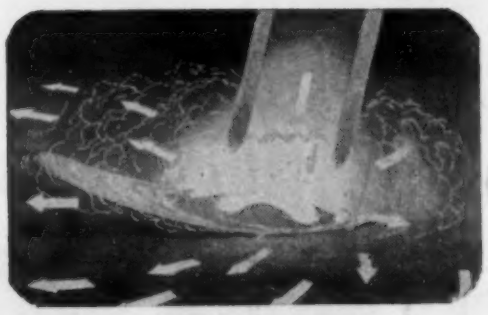
That is why, today, so many things are better buys in Alcoa Aluminum.

ALUMINUM COMPANY OF AMERICA, 660M Gulf Building, Pittsburgh 19, Pennsylvania. Sales offices in principal cities.

ALCOA **FIRST IN ALUMINUM**
THE METAL THAT LASTS

How can you cut costs with ARC WELDING?

See this film and find out!

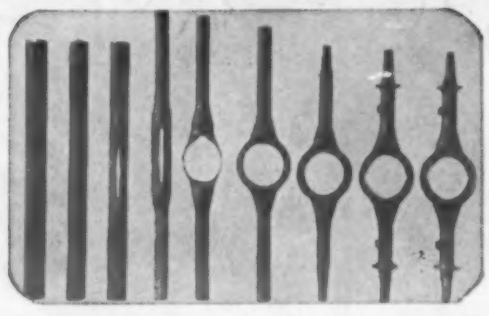


1. "ARC WELDING AT WORK", a 16mm full-color motion picture produced by General Electric, has a message for every cost-conscious executive who may be overlooking opportunities for arc welding in his own plant. A vivid animated treatment (above)...

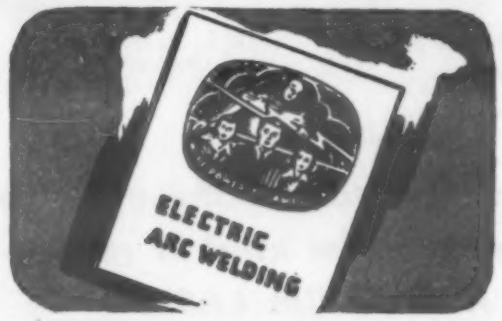
2...makes the technical parts of this film highly palatable. New uses for arc welding are suggested throughout. Welded building construction, for example (above) is shown to be efficient and economical. And as outdoor pressure vessels and piping . . .

3...become larger and more complicated the value of modern arc welding becomes more and more evident. In fabricating a consumer product like kitchen sinks (above), the film shows how high-quality welding adds extra eye appeal and salability.

4. As exemplified in this tubing machine (above) automatic arc welding is shown to offer almost limitless opportunities. Here, precise heat control is the big factor. Also, arc welding provides highly ductile joints, a fabricating requirement for . . .



5...this automotive rear-axle housing (above). These welded joints withstand ten severe stretching and swaging operations, with no sign of failure! Because we believe you can profit from a wider knowledge of arc welding, let us send you this . . .



6. ARC WELDING MANUAL . . . FREE! It has all the data you need to make an intelligent decision on this vital subject. [The complete program consists of a 30-minute film, manual and "highlights" booklets.] MAIL THE COUPON TODAY!

FREE
to business management!

General Electric Co., Section B684-13
Schenectady 5, N. Y.

Attach to your business letterhead

☐ Please send me a complimentary copy of the G-E Arc Welding Manual (GES-3491). (Extra copies at regular manual price—$1.25.)

☐ I'd like to borrow a 16mm print of the color film from my nearest G-E office.

Name_____ Title_____

Company_____

Street_____

City_____ State_____

GENERAL ELECTRIC

New Materials and Equipment

Strauss test (sulfuric acid) and to resist even aqua regia.

The austenitic alloys have tensile strengths up to 100,000 psi. as cast and up to 300,000 psi. as fine wire of 0.004-in. dia. Electrical conductivity is 15% higher than 18:8 stainless steel. Castability, finish, machinability and weldability by any method are claimed to be good.

New Welding Method

A new welding method, known as "Weldbrazing," is claimed to avoid harmful deterioration of the steel structure in the weld-zone as well as in the heat-affected zones, and to make possible welding of those types of steel not weldable by usual methods at the present time.

Instead of nonferrous alloys used in normal brazing, steel filler alloys are used to join and build up, without fusion, iron, steel, cast iron, copper, brass, bronze, nickel and other metals and alloys in similar or dissimilar metal combinations.

Use of these alloys in brazing makes it possible to reduce the heat input from 25 to 40% compared to fusion welding. The bonding occurs over the combined temperature range of fusion welding and brazing. Lower stresses and less warping and permanent deformation are claimed to result from this process.

The Weldbrazing principle is applicable to all types of gas and electric welding, and the method can be used with the usual welding equipment. A great number of Weldbrazing alloys have been developed by Uniworld for use in this process.

Chromium Plating Solution Has Higher Efficiency, Covering Power

An improved chromium plating solution has been developed recently by *United Chromium, Inc.*, 51 E. 42, New York 17.

Among the important advantages claimed for Unichrome SRHS are: (1) self-regulation; (2) higher cathode efficiency; (3) better covering power; (4) wider bright plate range; (5) lower sensitivity to interruptions in current; and (6) less tendency, when plated over nickel, to produce "rainbow plate" at the line where the chromium stops. Physical and chemical properties of the deposit are said to be the same as those of deposits from conventional solutions.

A single salt, Unichrome Compound Cr-100, is used to make up the SRHS solution,

STRENGTH COMBINED WITH BEAUTY

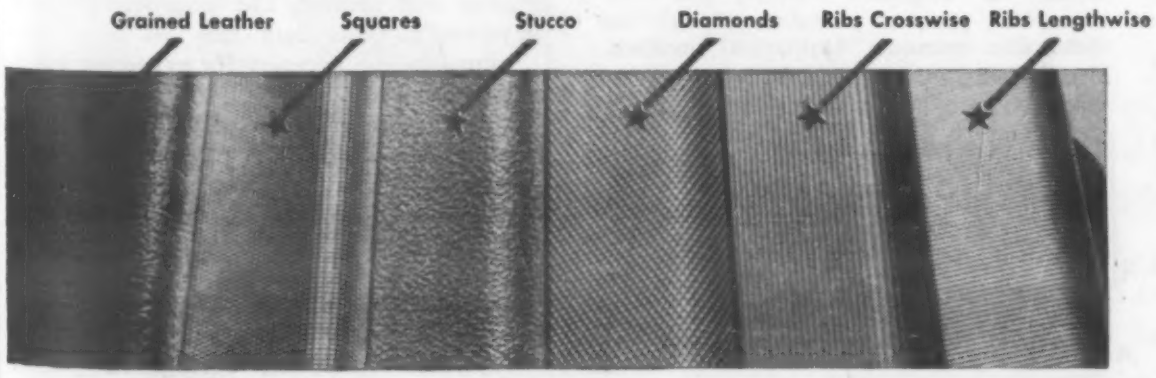
You get both with the new Reynolds Embossed Aluminum sheet finishes

● Designers' acceptance of the new Reynolds Embossed Aluminum patterns has spread rapidly—customers now acclaim it. The beauty of these smart new finishes is instantly apparent but it requires years of rugged wear to appreciate the greater rigidity, the scuff-resistant qualities embossing provides.

Above you see how three of the patterns serve in a modern motor bus interior. Ceiling is a vertical rib design; pleasing appearance and glare-reducing qualities mark its use at this point. On the dash panel a horizontal rib design adds a note of smart styling. Seat backs are protected by a diamond pattern—they take rough treatment, scuffs, dents and scratches, without showing wear. No other material serves so well, with so little maintenance, at such a low original cost.

If your product can use these new benefits without the addition of new costs, consider the range of attractive embossed patterns shown below. Remember you get a naturally pleasing finish, but it may also be painted when desirable. Scuffs and scratches are concealed by the pattern, and aluminum can be formed to modern contours, in most cases without new tool costs.

You get three times the material for production and reduced dead-weight because aluminum is ⅓ the weight of most metals. To see how your production picture can be brightened by Reynolds Aluminum, call your local Reynolds distributor or sales office listed under "Aluminum" in your classified telephone directory, or write to the address below.



FINISHES FOR ALUMINUM

Send your request for this informative book on your company letterhead and receive a copy without charge.

IF YOU SEE RUST... YOU KNOW IT'S NOT ALUMINUM

REYNOLDS METALS

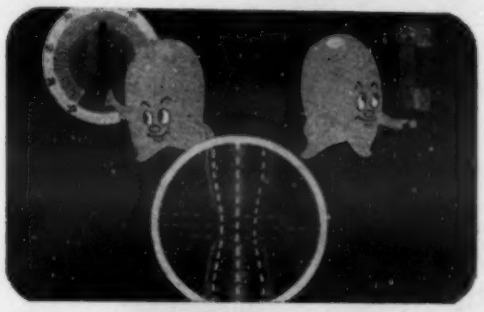
REYNOLDS METALS COMPANY, Aluminum Division
2560 SOUTH 3rd STREET • LOUISVILLE 1, KY.

REYNOLDS *Lifetime* ALUMINUM

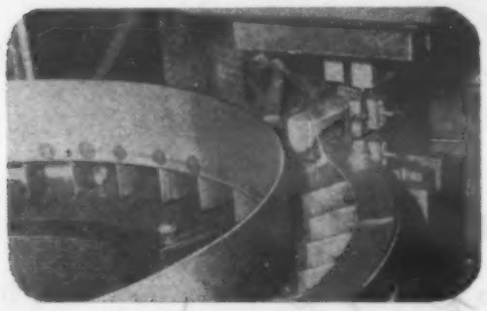
CONSIDER ALUMINUM... CONSULT REYNOLDS... THE COMPLETE ALUMINUM SERVICE

Can Resistance Welding Cut YOUR ASSEMBLY COSTS?

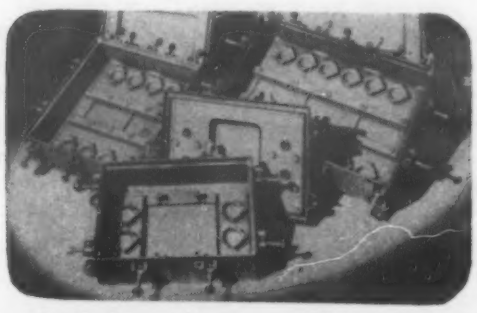
See this film and find out!



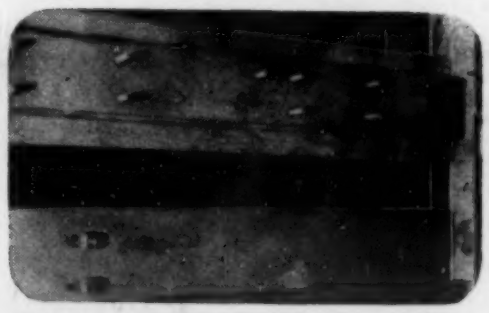
1. **"THIS IS RESISTANCE WELDING"**, a full-color sound motion picture prepared by General Electric, will appeal to management, engineers, and shop men. Filmed with the layman in mind, this picture makes liberal use of cartoons (above) to simplify . . .



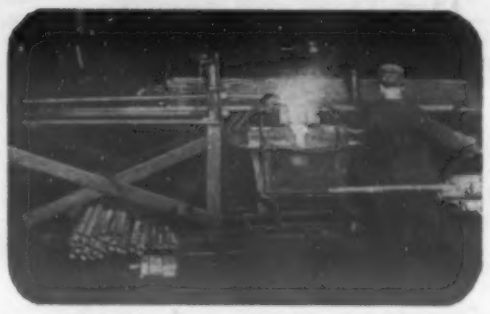
2 . . . the more technical aspects of resistance welding. Principal objective of the film, though, is to explain how resistance welding cuts fabricating and assembly costs. One application shown is the assembly of a blower rotor (above) where clearances . . .



3 . . . had always been a problem. Resistance welding cut manufacturing time by 75%! Another big saving dramatized in the film is the case of the switch boxes (above). These were formerly sand cast with holes individually located, drilled and tapped.



4. These are now completely welded on a continuous basis and production is up from a few hundred to 1000 units a day! The audience is also shown how another manufacturer welded studs on a steel cubicle framework (above) in one operation . . .



5 . . . instead of the seven formerly required! And for the cost-conscious executive, there's the story about the railroad that used resistance welding to save expensive seamless tubing (above). To give you a "preview" of this worthwhile film let us send you this . . .

6. **RESISTANCE WELDING MANUAL . . . FREE!** It's jam-packed with the kind of information on resistance welding you want. [Complete program consists of full-color 16mm film, manual, "highlights" booklets.] MAIL THE COUPON TODAY!

FREE
to business management!

General Electric Co., Section A684-14
Schenectady 5, N. Y.

Attach to your business letterhead

☐ Please send me a complimentary copy of the G-E Resistance Welding Manual (GES-3393). (Extra copies at regular manual price—$1.00.)

☐ I'd like to borrow a 16mm print of the film from your nearest film library.

Name_____ Title_____

Company_____

Street_____

City_____ State_____

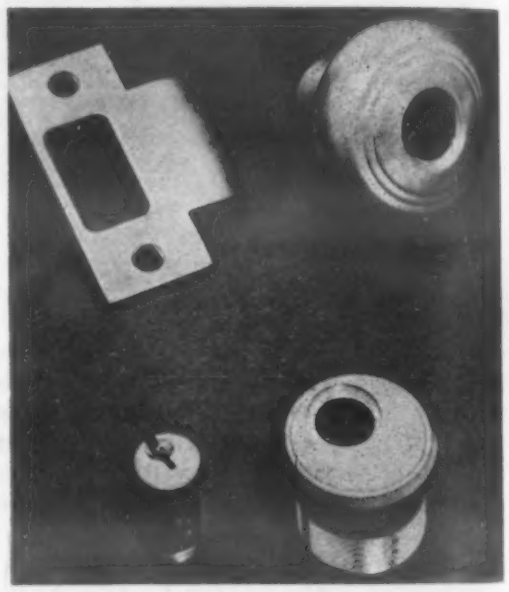
GENERAL ELECTRIC

New Materials and Equipment

and the only regular maintenance required is the addition of SRHS compound to adjust the concentration to the desired specific gravity. The acid catalyst radical concentration is automatically self regulated, eliminating the necessity for chemical analysis in maintaining the correct plating balance.

As a result of higher cathode efficiencies, deposits of equal thickness can be obtained in less time than with the conventional solution. Power savings are also realized.

Because the SRHS bath permits use of



Pictured here are objects which have been successfully chromium-plated with United Chromium's new solution.

higher current densities under the same conditions of concentration and temperature, it is possible to shorten the plating time still further. The improved covering power of this bath may in some cases eliminate the necessity for expensive auxiliary anodes.

The wider bright plate range of the SRHS bath allows the plater to use higher current density without the danger of chromium burning in the high current density areas. Good coverage at low current densities is also possible.

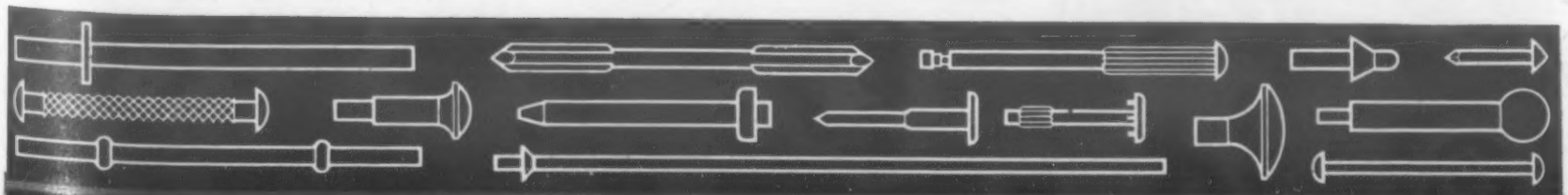
Occurrence of gray chromium, caused by plating over passive nickel or by interruptions of current during the plating process, is said to be reduced by the new solution.

● Revision of several features of the gas-fired forge furnaces manufactured by *Eclipse Fuel Engineering Co.*, Rockford, Ill., has been announced recently. Designed for continuous duty at 2200 F, these furnaces have been made safer and more economical to operate.

The trained hand of Hassall offers you:

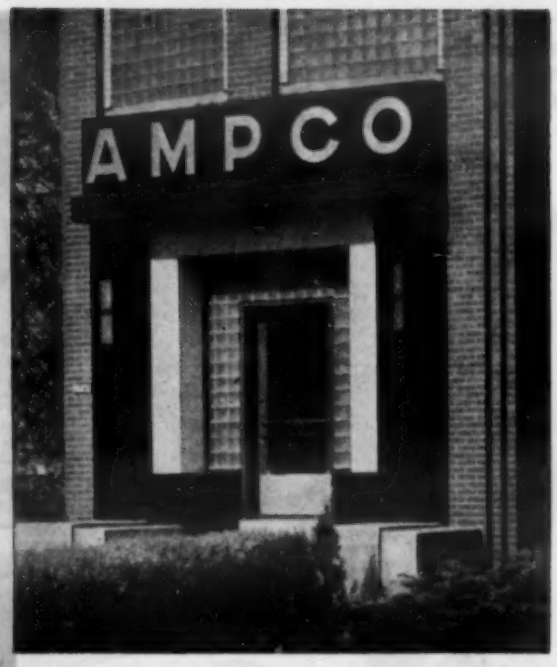
SPECIAL NAILS RIVETS SCREWS
Hassall
ESTABLISHED 1850

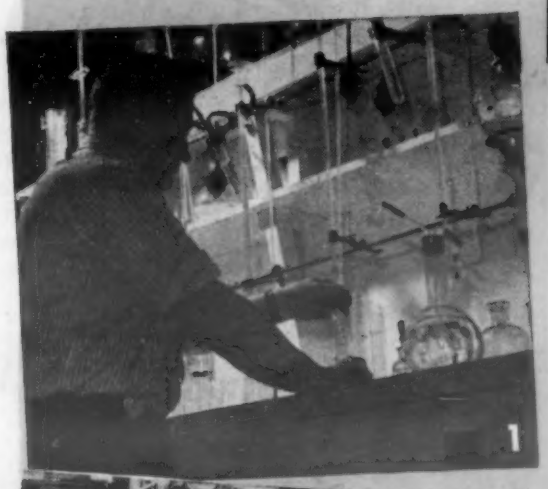
HASSALL cold-heading may solve your immediate special part problem... Special nails, rivets and threaded parts made in diameters from 1/32" to 3/8"—lengths up to 7"... Rivets 3/32" diameter and smaller a specialty...also small threaded blanks ...Variety of metals, finishes and secondary operations... Economy, quality and quick delivery in large or small quantities... Your inquiries answered promptly...ASK FOR FREE CATALOG ...3-color DECIMAL EQUIVALENTS WALL CHART free on request.



JOHN HASSALL, INC. • 162 CLAY STREET • BROOKLYN 22, N. Y.

AMPCO Versatility helps you Cut Costs





"AMPCO METAL"... a by-word in INDUSTRY — The COMPANY and...a PRODUCT of that company

35 YEARS OF PROGRESS... Founded in 1914 to produce sand castings made from AMPCO METAL... a hi-iron aluminum bronze, the Company has grown steadily and expanded its facilities and the scope of its activities to the point where it is now an organization specializing in the production of non-ferrous alloys and products made therefrom.

Produced under close laboratory control, Ampco aluminum bronze alloys are available as: *sand and centrifugal castings; extruded rod, tube and simple shapes; rolled sheet and plate; forgings; arc and resistance welding electrodes; machined parts; valves; pumps and fabricated assemblies.*

In addition to aluminum bronzes (still the major product) Ampco Metal produces, under the same laboratory control, many other copper-base alloys including: phosphor bronzes; tin bronzes; nickel bronzes; manganese bronzes and Ampco Beryllium-copper.

Ask an Ampco Field Engineer for further details... make full use of our engineering service.

1. Laboratory Control and Research.
2. Modern Sand Foundry for job or production work.
3. Centrifugal Foundry... producing castings weighing less than a pound to more than 6000 pounds.
4. Pouring billets for Extrusion Mill.
5. Machine Shop specializing in aircraft work.

FOR COMPLETE DETAILS —
tear out this coupon and mail today.

Ampco Metal, Inc.
Dept. MA-12, Milwaukee 4, Wis.

Name.....Position.....
Company.....
Company Address.....
City.....(...) State.....
G-3

AMPCO METAL, INC.
MILWAUKEE 4, WISCONSIN

West of the Rockies, it's the Ampco West Coast Plant, Burbank, Calif.

New Materials and Equipment

Automatic Hydraulic Bender Series Handles Tubes Up to 3-In. Dia.

A new series of high-speed hydraulic automatic tube and miscellaneous bending machines has been announced by *Acme-Winter Corp.*, Buffalo 13, N. Y. The machines are furnished in several sizes for bending tubes up to 3-in. O.D. and ¼-in. wall thickness.

The standard machines are equipped with six automatic stops for various degrees of bends, and are indexed automatically. They bend either right or left with standard dies, and can be furnished with hand control and automatic mandrel ejector. Special extension tables and adjustable gages can be supplied to suit individual requirements. A short bending head allows the operator to work in front of the machine.

This Acme-Winter tube bender has six automatic stops for various degrees of bends.

New Developments Announced in Testing Machine Equipment

Four innovations in testing machine equipment have been announced recently by *Tinius Olsen Testing Co.*, Easton Rd., Willow Grove, Pa. In addition to changes on the "L" Type Hydraulic Testing Machine, a new Electronic Recorder, an LC Type Testing Machine and an Electrodyne Indicator Type EAA have been developed.

A new low load range of 1000 lb., reading by 2-lb. dial marks, can be provided on the "L" Type Hydraulic Testing Machine. The electronic system making possible this low load range will shortly be available for all Olsen "L" Type hydraulic testers, thus increasing their versatility where accurate low ranges are required.

The new Olsen Electronic Recorder can be used with either an extensometer or

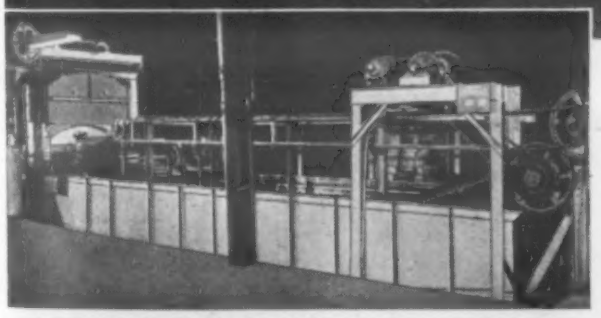
No. 97 of a Series of Typical Installations

Sunbeam
STEWART
THE BEST INDUSTRIAL FURNACES MADE

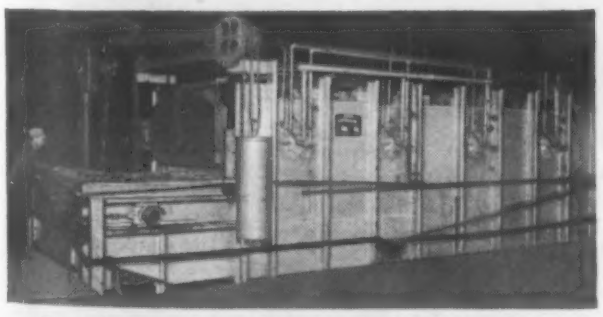
HEAT TREATING RAILWAY AND INDUSTRIAL SPRINGS

At AMERICAN-FORT PITT SPRING DIV., McKEES ROCKS, PA.

Overall view of the integrated Sunbeam Stewart Harden, Quench and Draw heat treating line (approximately 100 ft. long) for helical springs. This installation is capable of handling 3,500 lbs. per hour.



An exclusive double belt conveys springs through the quenching oil. This design eliminates impact, permits an even quench along the longitudinal axis of the spring.



Overall dimensions of the Hardening Furnace are 11½′ by 30½′, with a usable hearth space of 54″ by 25′.

This is Number 97 in a series of typical installations showing how Sunbeam Stewart Furnaces are helping manufacturers reduce costs and keep themselves competitive. These installations also demonstrate the wide variety of specific requirements in the metal-working industry Sunbeam Stewart Furnaces are designed to meet.

Springs manufactured by American-Fort Pitt Spring Division of the H. K. Porter Co., Inc., are such as those used in the agricultural implement and railroad fields, with a monthly production of about 700 to 800 tons.

To eliminate distortion of springs due to shock and impact, a double belt conveyor automatically delivers springs from the Hardening Furnace *through the quench tank* to the Draw Furnace. The upper belt runs slack so that its weight holds the spring firmly until quenched.

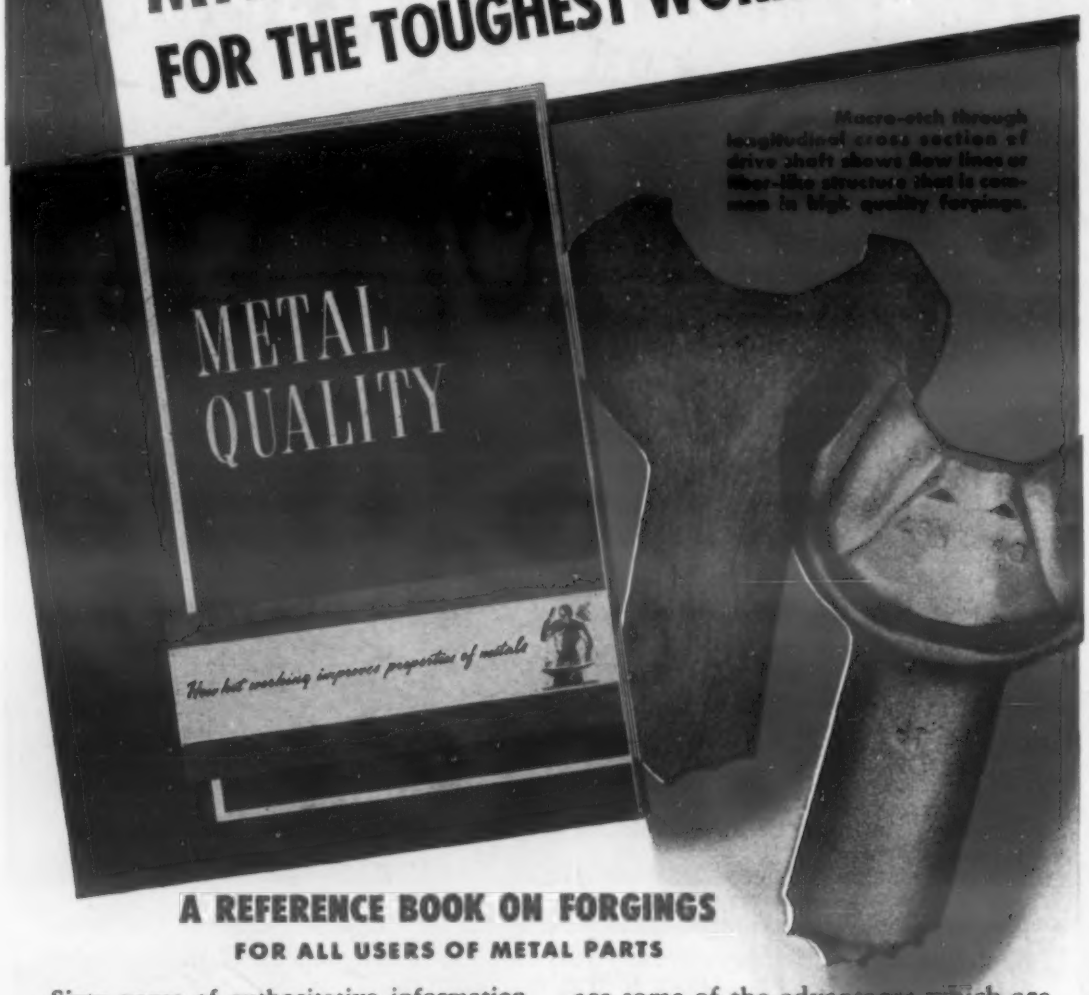
It will pay to consult Sunbeam Stewart on your heat treating problems. In addition to continuous conveyor units, Sunbeam Stewart builds a full line of standard furnaces and galvanizing equipment.

SUNBEAM STEWART INDUSTRIAL FURNACE DIVISION of SUNBEAM CORPORATION
(*Formerly* CHICAGO FLEXIBLE SHAFT CO.)

Main Office: Dept. 111, 4433 Ogden Ave., Chicago 23 — *New York Office:* 322 W. 48th St., New York 19 — *Detroit Office:* 3049 E. Grand Blvd., Detroit
Canada Factory: 321 Weston Rd., So., Toronto 9

A letter, wire or 'phone call will promptly bring you information and details on SUNBEAM STEWART furnaces, either units for which plans are now ready or units especially designed to meet your needs. Or, if you prefer, a SUNBEAM STEWART engineer will be glad to call and discuss your heat treating problems with you.

THE METAL QUALITY FOUND IN FORGINGS PROVIDES MATCHLESS CAPACITY FOR THE TOUGHEST WORK LOADS


METAL QUALITY
How hot working improves properties of metals
Macro-etch through longitudinal cross section of drive shaft shows flow lines or fiber-like structure that is common in high quality forgings.

A REFERENCE BOOK ON FORGINGS

FOR ALL USERS OF METAL PARTS

Sixty pages of authoritative information on metal quality as developed in forgings formed through the use of closed impression dies. Forging production techniques are described and illustrated; economic advantages of forgings are presented from the viewpoint of top management, design engineers, metallurgists and production executives. Your copy is ready. Fill in and attach coupon below to your business letterhead.

* * *

A product fortified with the metal quality found in forgings outperforms other products. Forgings' grain structure and fiber-like flow lines are controlled, directioned, and concentrated at points where the highest stress and shock occur under actual service conditions. High tensile and impact strength, the reduction of dead weight, and freedom from concealed defects are some of the advantages which are obtainable in forgings.

Now is an excellent time to check your product for cost reductions—explore every possibility to improve performance and appearance, while reducing dead weight of component parts. Double check all parts subject to the greatest stress and strain. Check machining and finishing time schedules—forgings have been known to speed up production by 250 per cent. Rejects at the point of assembly are costly—a needless waste; forgings offer practically a 100 per cent yield of sound parts—and they respond uniformly to heat treatment. Consult a forging engineer—only a forging engineer can inform you fully regarding the many advantages obtainable with forgings.

DROP FORGING ASSOCIATION
605 HANNA BUILDING
CLEVELAND 15, OHIO

Please send 60-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metal", 1949 Edition.

Name .....

Position .....

Company .....

Address .....

New Materials and Equipment

compressometer for recording tension, compression and transverse test data. It provides strain magnifications of 1000:1, 500:1, 250:1, 200:1, 100:1, 50:1, 20:1 and 10:1, all secured from a single multiposition switch. Values of the test data are not affected by changing from one magnification to another during a test.

A compact, low-cost testing machine, LC Type, has been developed for standard tensile, compression and transverse tests of metals and other materials. It is provided with dual capacity ranges of 10,000 and 1,000 lb. Hand-operated bench models and motor-powered floor units are available.

The Electrodyne Indicator Type EAA is claimed to eliminate completely the human element in finding unbalance in rotating parts. When a rotor is placed in the Olsen Type E-O Balancing Machine, and the machine has been started, the new indicator shows immediately both the amount of unbalance and the location of unbalance in the preselected correction planes.

● A new model of the portable "hand pour" furnace, which will melt up to 1½ lb. of brass or ½ lb. of aluminum, is being manufactured by *Jelrus Co., Inc.*, 136 W. 52 St., New York 19. The small furnace, designed for metallurgical investigations, is equipped with a pyrometer that indicates the metal temperature. The maximum temperature obtainable is 2000 F and the time required to melt a pound of metal is about 10 min.

New Combustion Control Models to Safeguard Firing Systems

Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, is now manufacturing a new Flame-otrol combustion safeguard for industrial and commerical fuel-fired furnaces, ovens, boilers, kilns, and other treating equipment.

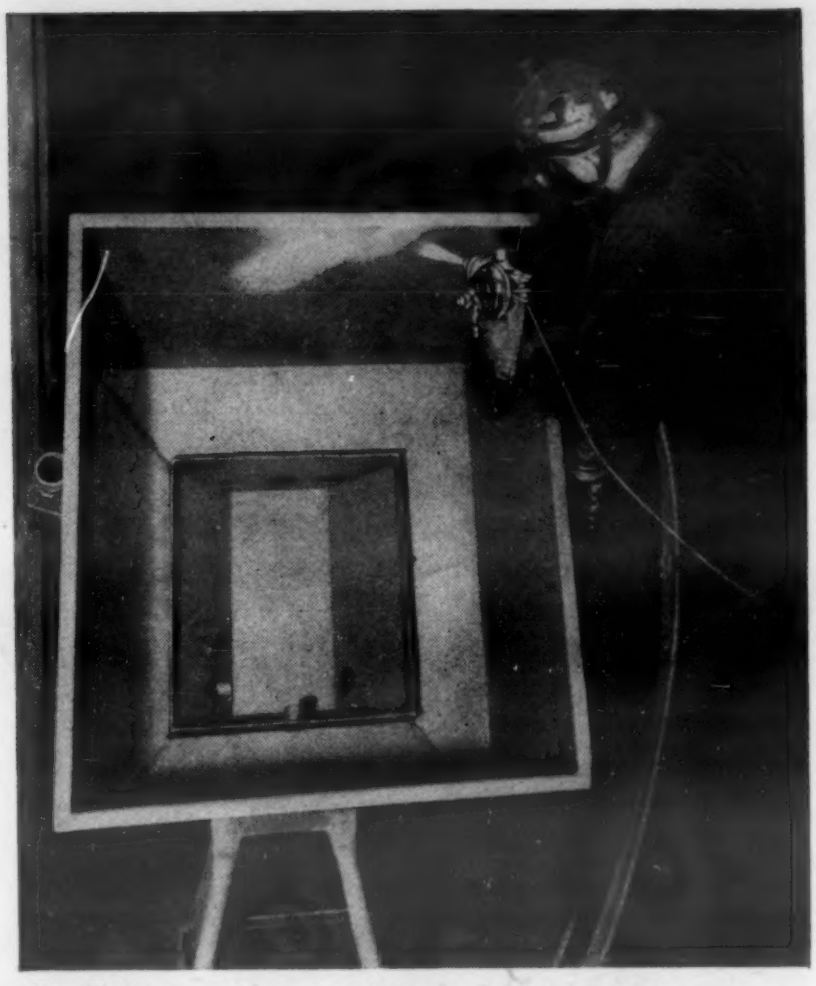
The 1300 Series instrument uses a simple electronic circuit to cause instantaneous shut-off action at the fuel valves in case of absence of the flame. It operates with equal efficiency on gas, oil or any combination of these fuels, and the electronic control unit is the same for all ap-

NOW— it can be told— METALLIZING STOPS CORROSION

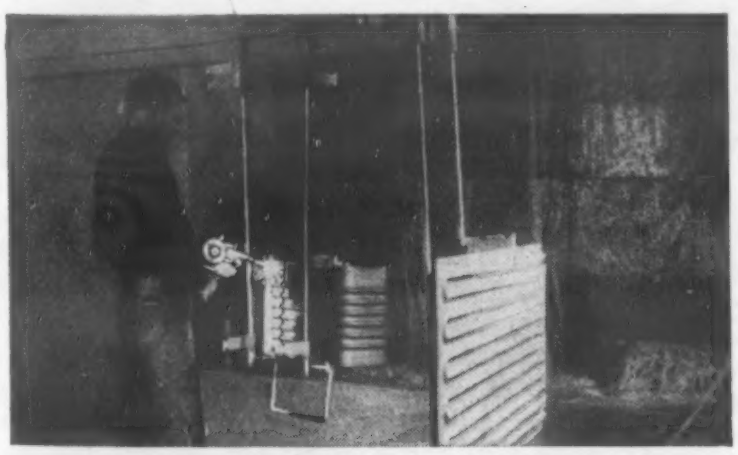
. . . not for one, two, or even ten years—but from 20 to 50 years under severe service conditions.

We have long known that metallizing stops corrosion. Accelerated tests in the laboratory demonstrated that much, and many manufacturers have been using it for years in product finishing. But we wanted a good long backlog of actual case histories before telling design and production men, *for sure,* what metallizing would actually do to help solve specific corrosion problems in *their* products. Now we have them.

FOR INSTANCE: One interesting application involves a manufacturer of special fasteners fabricated from high carbon spring steel. Previously, they had cadmium plated the fasteners for corrosion resistance. Unfortunately, the fasteners picked up free hydrogen in the process, causing embrittlement and requiring 20 hours' baking to release it. Painting was tried and discarded because it interfered with electrical conductivity. Now they metallize the fasteners with pure zinc, .0005″ thick, after grit blasting in tumbling barrels. Entire process takes one hour as against the 20 hours required for one operation alone with plating. Salt spray tests show a 40% increase in breakdown resistance over the old process.



Metallizing corrosion protective zinc coating on degreaser.



Production-line metallizing of refrigerator cold plates to prevent corrosion.

A large electrical company sprays zinc on its outdoor hanger-type capacitors, .005″ to .006″, for a life expectancy of 15 to 30 years. User states, "This new finish has greater resistance to abrasion. Even if scratches penetrate through the zinc coating, the zinc provides electro-chemical protection."

Wherever you have a corrosion problem in your product, from tanks, degreasers, refrigerator trucks and cold plates, fans, filter beds, capacitors, transformers, pole-line hardware—metallizing may prove well worth your while to look into. It's easy to use—no more complex than spraying paint; simple to apply, even after assembly is complete. Fast, too; modern metallizing guns will spray as much as 55 pounds of zinc per hour.

Write for full information today.

FREE BULLETIN—

Bulletin 62—"Stop Corrosion with Metallizing" provides data and pictures on many different types of jobs; includes spray test and life expectancy charts. Yours for the asking—just clip and send off the coupon. No obligation, of course. *Metco—Reg. U. S. Pat. Off.

METALLIZING ENGINEERING CO., INC.
38-23 30TH STREET — METCO — LONG ISLAND CITY 1, N. Y.

R. J. McWaters
Metallizing Engineering Co., Inc.
38-23 30th St., Long Island City 1, New York

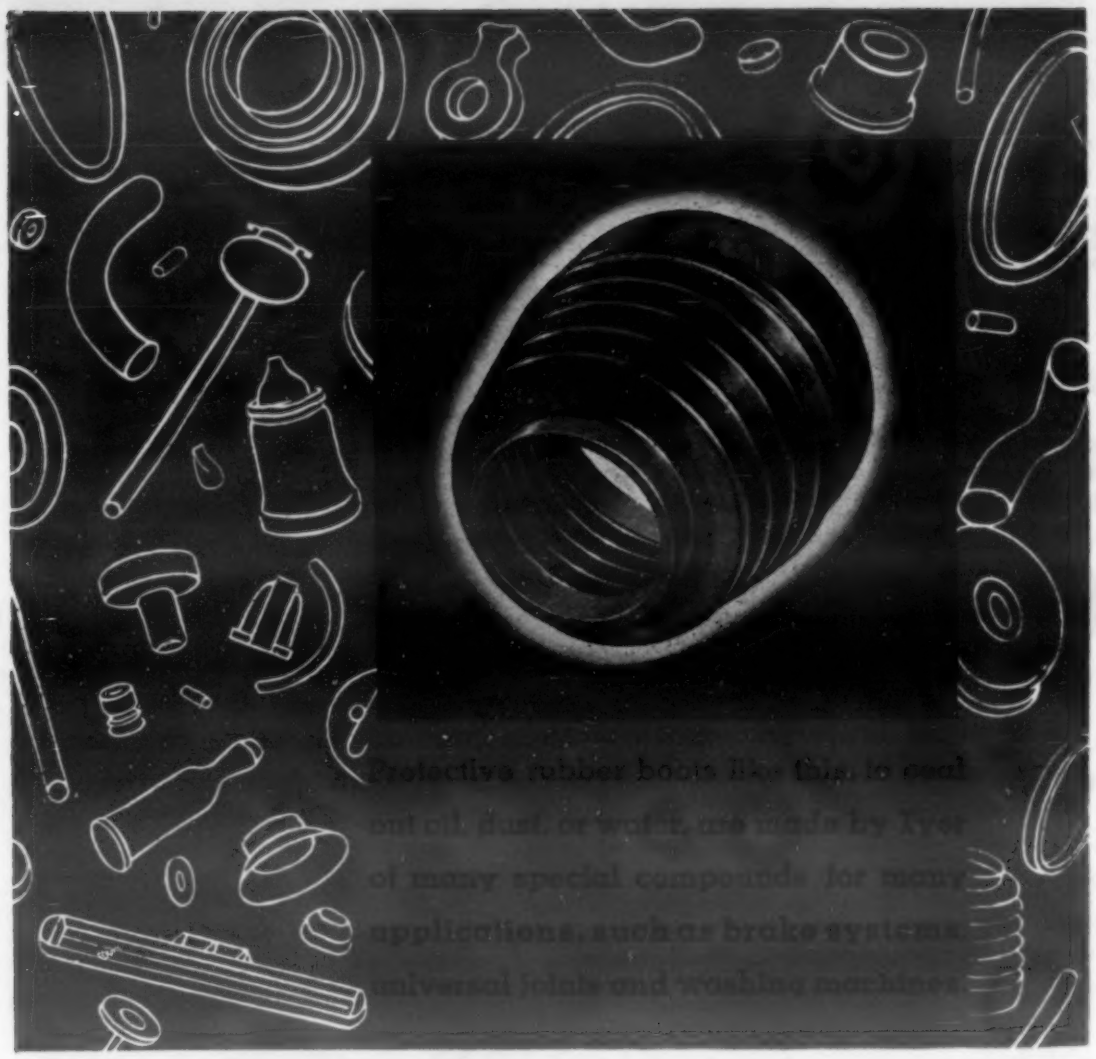
Please send me Bulletin 62.

NAME_____

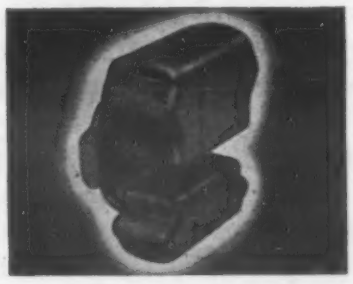
COMPANY_____

ADDRESS_____

CITY_____ STATE_____



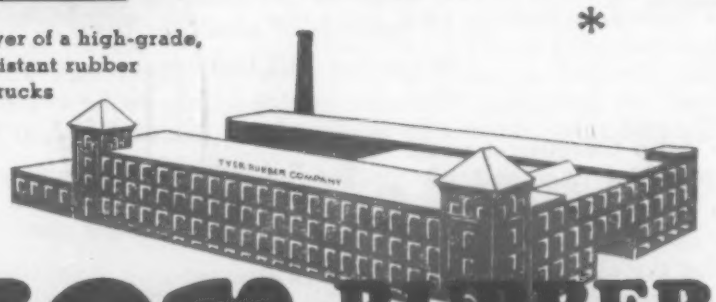
For 92 years Tyer has been doing remarkable things with rubber. Tyer originated WHITE RUBBER and ELASTIC WEBBING. Tyer's war products ranged from giant pontons to tiny earplugs made to a tolerance of one thousandth of an inch. Today Tyer leads in SERVICE to INDUSTRY. Many of the country's finest products have vital rubber parts made by Tyer. These famous manufacturers know that Tyer does unusual things with rubber.



If there is a rubber part in your product (old, new or proposed) Tyer technicians will give you the utmost cooperation in putting all Tyer's 92 years of experience at your service. Ask the Tyer representative. Write to us in Andover or to the nearest branch.

A shock insulator made by Tyer of a high-grade, resilient, oil and weather resistant rubber compound to protect heavy trucks from road shocks.

*



Tyer RUBBER COMPANY

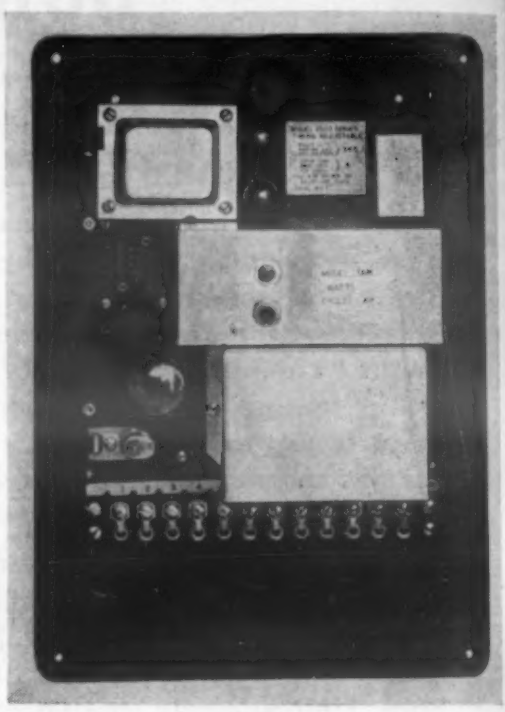
* **ANDOVER, MASSACHUSETTS**

159 Duane St., NEW YORK 189 W. Madison St., CHICAGO 3-252 Gen. Motors Bldg., DETROIT

New Materials and Equipment

plications. However, different sensing elements are used.

The new series consists of a basic universal chassis into which various plug-in units can be inserted, permitting the selection of



Shown here is an open view of the Flame-otrol with the plug-in unit for Model 1301.

the desired operational sequence; seven different models are available.

An automatic proving or checking period guarantees a safe start. It prevents operation until the electronic and sensing circuits are automatically checked against component failures, open or short circuits, leakage or grounding, and tube failure.

X-Ray Gage Measures Thickness of Cold Rolled Steel Strips

The thickness of cold rolled steel strips ranging from 0.0050 to 0.1196 in. can be measured in steps of 0.0001 in. by a new X-ray gage available from *Westinghouse Electric Corp.*, P. O. Box 868, Pittsburgh 30, Pa.

The gage compares the amount of X-ray absorption from two X-ray beams identical in intensity, one through a sample of steel of the exact thickness to be rolled. The results are interpreted visually. Electrical and radiation protection are provided to safeguard personnel.

FOR AIRCRAFT DIMPLING DIES

67 Chisel

withstands shock, wear and heat

These small, two-piece dies sink thousands of "dimples" in the aluminum skin of aircraft sections. They make conical depressions so that rivet heads can be driven in flush with the surface to provide maximum streamlining. Operated at a temperature of 600 F, the dies also do a spot-annealing job, relieving the local stresses set up in the thin aluminum-alloy sheets during the dimpling operation.

Bethlehem 67 Chisel is used for this job because this chrome-tungsten tool steel has high shock-resistance . . . it resists wear . . . it has good red-hardness . . . it is easy to machine and heat-treat.

67 Chisel is a versatile tool steel. It's suitable for such hot-work tools as headers, piercers, drop-forge die inserts and forming equipment where operating temperatures are below 1050 F. It is also excellent for cold-work tools like chipping chisels, swaging dies, battering tools, shear blades, punches and forming dies. Carburized for extra wear-resistance, 67 Chisel is the first choice for master hobs used in cold-hobbing cavity molds.

Hardened at 1750 F and oil quenched, it has a Charpy impact value of 180 ft-lb and a Rockwell-C hardness of 56.5 after tempering at 400 F.

Typical Analysis:

C	Si	Cr	W	V
0.50	0.75	1.15	2.50	0.20

67 Chisel is available in many sizes and sections in our mill depot . . . and it's also kept in stock by many of our distributors. Get complete information from the nearest Bethlehem sales office or tool steel distributor. Better still, order a test bar and see for yourself how tough 67 Chisel really is!

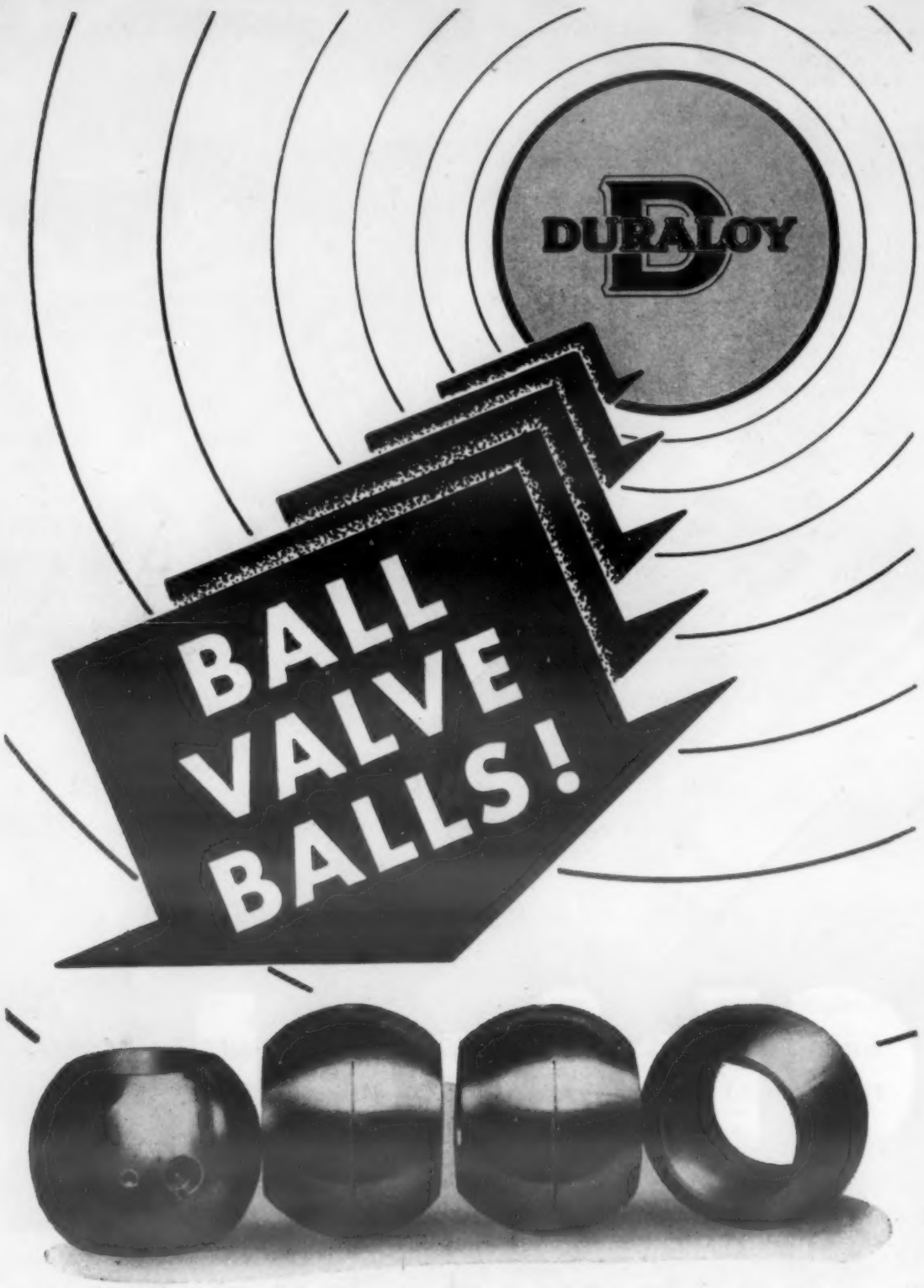
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Export Distributor:
Bethlehem Steel Export Corporation

BETHLEHEM STEEL

67 Chisel . . . one of Bethlehem's Fine Tool Steels



These are 12% chrome-iron, cast statically. They're machined and finished to close tolerances.

Producing chrome-iron, chrome-nickel and nickel-chrome static castings has been our business exclusively since 1922. We helped pioneer this phase of the high alloy casting business just as we helped pioneer centrifugal castings beginning in 1931.

At Scottdale, we have one of the most modern high alloy foundries in the country. We have exceptional technical controls and a 400,000 volt X-ray machine. We can produce individual static castings up to 7½ tons in weight and machine or otherwise finish them to specifications.

In short, we have a broad reliable service in connection with high alloy castings.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • *Eastern Office:* 12 East 41st Street, New York 17, N. Y.

F. O. NELSON
1743 McCormick Building
Chicago, Illinois

Detroit
F. B. CORNELL & ASSOCIATES

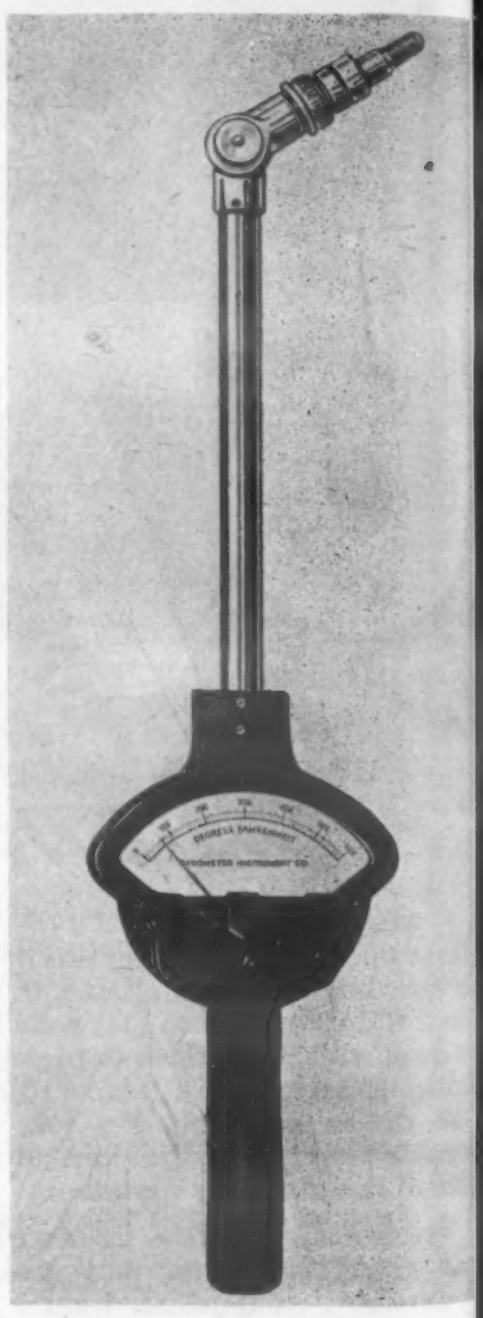
METAL GOODS CORP. St. Louis • Houston • Dallas • Tulsa • New Orleans • Kansas City

New Materials and Equipment

All-Purpose Pyrometer Determines Surface, Sub-Surface Temperatures

An all-purpose pyrometer for determining surface and sub-surface temperatures in almost any installation has been developed by *Pyrometer Instrument Co., Inc.*, Bergenfield, N. J.

The portable instrument features a 4



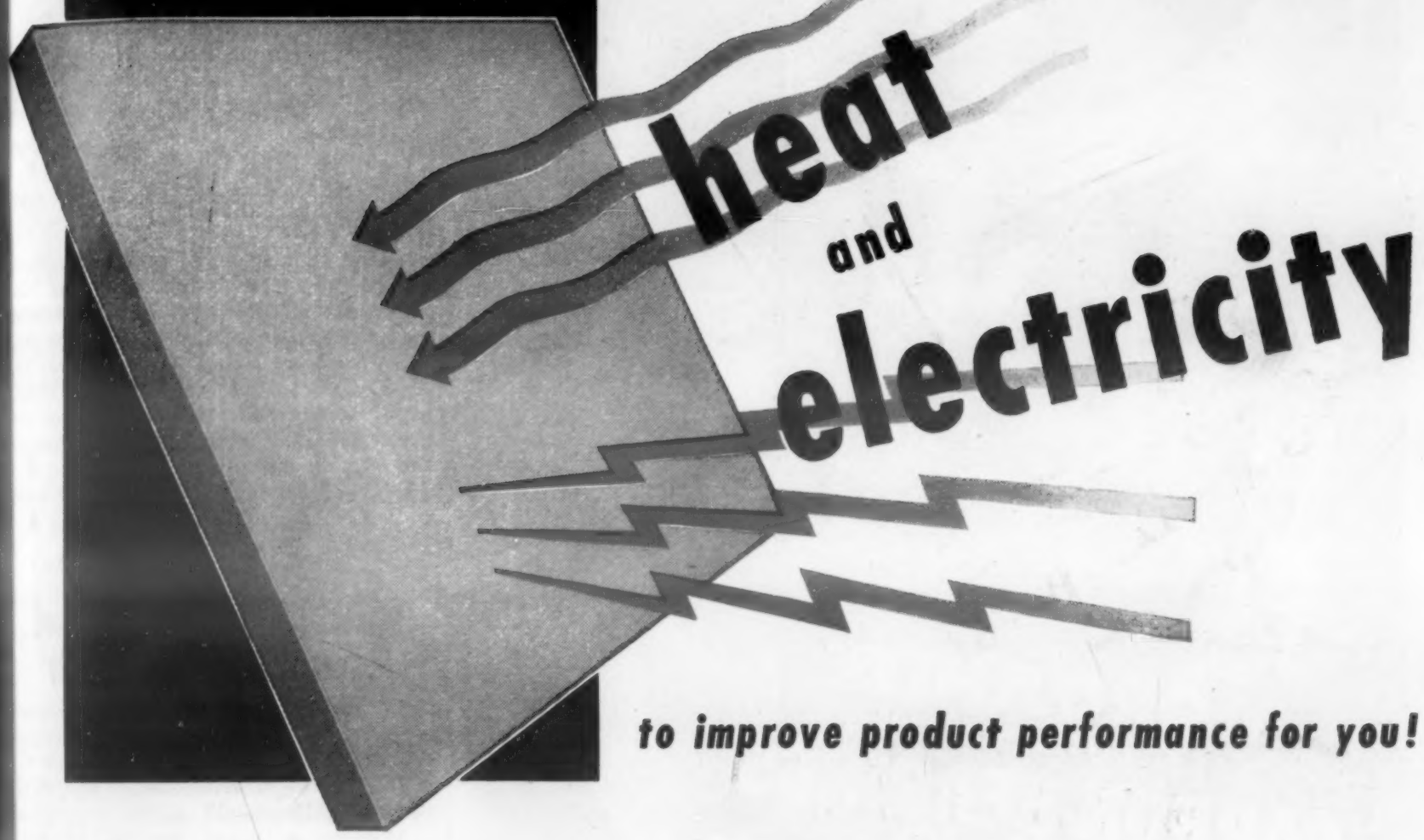
This new Pyrometer Instrument C device can be supplied with either a rig or flexible arm.

in. direct-reading indicator mounted in rubber-cushioned housing, thus offering great ease in reading as well as long service. Two distinct series of models have either a rigid extension arm or a 42-in. flexible arm, both suitable for use with one or more of eight available thermocouples.

Each series of instruments is obtainable

NEW C-D Silicone Dilecto

withstands an inferno of



to improve product performance for you!

There are three new grades of C-D Dilecto* that can withstand temperatures as high as 250°C. They are chemically inert, silicone-glass laminated plastics that offer exceptionally high heat resistance and good arc resistance, extra strength, and positive moisture resistance! At Continental-Diamond we've literally lived and worked with Silicone Dilecto—perfecting it to a point where we believe it can be highly useful in helping to solve your production problems — and improve product performance.

And this remarkable plastic is but one of many in the C-D family. They provide practical combinations of mechanical, electrical, and chemical properties—structural strength, light weight, positive moisture, heat and corrosion resistance. In hundreds of plants, C-D Plastics—Fibre, Vulcoid, Dilecto, Celoron, and Micabond—offer proof that it pays to see C-D first in your search for the right plastic for the job. For interesting, useful information on Silicone Dilecto, and other C-D high strength plastics, call or write your nearest C-D office, soon.

your partner in producing better products

*Dilecto GB—112—S
Dilecto GB—128—S
Dilecto GB—261—S

E-2-49

BRANCH OFFICES: NEW YORK 17 • CLEVELAND 14 • CHICAGO 11 • SPARTANBURG, S. C. • SALES OFFICES IN PRINCIPAL CITIES
WEST COAST REPRESENTATIVE: MARWOOD LTD., SAN FRANCISCO 3 • IN CANADA: DIAMOND STATE FIBRE CO. OF CANADA, LTD., TORONTO 8

Continental-Diamond FIBRE COMPANY

Established 1895 . . . Manufacturers of Laminated Plastics since 1911 — NEWARK 25 DELAWARE

PROBLEM: Outboard bearings on extended pin roller chain conveyor . . . to withstand degreasing vapor, dipping bath fumes, high heat, water dip, steam, acid spray, etc.

SOLUTION: A Morganite bearing . . . the special bearing for special conditions . . . meets all requirements . . . is entirely self-lubricating under all conditions.

SELF-LUBRICATING MORGANITE OUTBOARD BEARINGS ON CONVEYOR BELT ROLLER CHAIN

MORGANITE
SELF-LUBRICATING
CARBON BEARINGS

One application that clearly demonstrates the special properties of Morganite bearings is their use on conveyor belts involving continuous changes of atmosphere and temperature. Bearings, pump blades and seal rings of Morganite easily withstand these conditions . . . actually operate better when submerged in liquids. They are immune to oil, petroleum, water, brine, most acids and alkalies. Being self-lubricating they do not contaminate contacting liquids and materials with grease or oil, impart no odor or taste.

see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

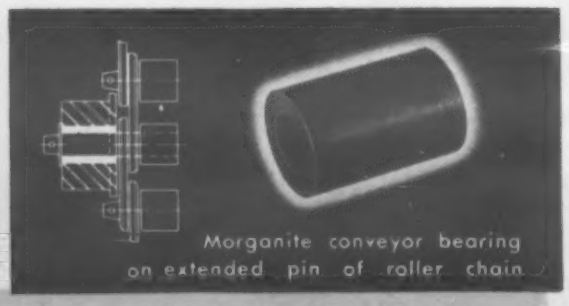
Additional data on Morganite will be found in Sweet's File for Product Designers. For competent engineering help on specific problems consult a Morganite sales engineer.

REGISTERED TRADE MARK

Morganite INCORPORATED

LONG ISLAND CITY 1, NEW YORK

Conveyor hanger roller with Morganite bearing requires no lubrication



Morganite conveyor bearing on extended pin of roller chain

Manufacturers of Morganite Carbon Brushes for all motor and generator applications, and Morganite Carbon Piles.

New Materials and Equipment

in four temperature ranges from F to 0 to 1200 F, and all thermocouples can be interchanged without adjustment or recalibration.

● Mild steel up to 20 gage in thickness can be cut at the continuous rate of 125 strokes per min. by a new line of high-speed power shears introduced recently by *Niagara Machine & Tool Works,* Buffalo 11, N. Y. Designed for light-gage sheet metal, these machines offer full visibility of the cutting edge through the arched openings and over the top of the holddown bar, thus facilitating shearing to accurate layout lines.

Plastic Mold and Die Lubricant Increases Production, Quality

A lubricant trade-named Moldeze, claimed to prevent plastic compounds from adhering to molds and dies, has been announced by *Protective Coatings, Inc.,* P. O. Box 3985, Detroit 27.

Moldeze, a liquid applied by mist spraying, is said to be an efficient and economical treatment for insuring continuous mold parting, increased production, minimized rejects, and elimination of dam-

The Moldeze treatment for molds and dies need be renewed only at extended intervals.

age to molds and dies. Molds and dies require Moldeze treatments only at extended intervals.

The manufacturers of this new lubricant also claim that it does not cloud, mar or

NI-RESIST...
AN ECONOMICAL METAL
for resisting Corrosion, Erosion and Metal-to-Metal Wear

NI-RESIST* is the trade name of a high nickel cast iron – one of the most economical corrosion-resistant engineering materials ever developed.

NI-RESIST, mechanically similar to gray iron, and resembling austenitic stainless steel in many characteristics, provides a unique combination of properties at moderate cost . . .

RESISTS CORROSION

NI-RESIST resists corrosive attacks of *acids, alkalies* and *salts* to a degree unmatched by any other product of the cast iron industry. In strong corrosives it has 20 to 200 times the resistance of plain iron, and 5 to 50 times the resistance in mild environments.

CURBS WEAR

NI-RESIST reduces wear and galling, because graphite particles are distributed throughout its structure, as in gray iron. From this, and its work-hardening characteristics, come the superiority of NI-RESIST castings for components in metal-to-metal wear service.

CHECKS EROSION

This superior wear-resistance . . . together with inherent resistance to corrosion . . . makes NI-RESIST an outstanding material for curbing erosion by liquids and slurries. By long, trouble-free control of erosion, NI-RESIST castings reduce maintenance costs, production tie-ups and the expense of replacements.

WITHSTANDS HEAT

Although primarily used to resist corrosion, erosion and metal-to-metal wear . . . NI-RESIST is also specified for resistance to elevated temperature effects. Castings of NI-RESIST show up to 10 times better scaling resistance, and up to 12 times better growth resistance than those of plain iron at 1300 to 1500°F.

MACHINABILITY and OTHER PROPERTIES

NI-RESIST of normal hardness can be machined as readily as gray iron of about 200 BHN.

NI-RESIST has high specific electrical resistance. Thermal expansion can be controlled, from 60 per cent higher than that of plain iron to a low approximating that of Invar.

NI-RESIST is usually lower in cost than most other corrosion-resistant alloys. It is produced by authorized foundries only, in all industrial centers of the country. NI-RESIST castings have no more limitations in size and complexity than those of any gray iron.

APPLICATIONS

Several types of NI-RESIST *are available. All provide the fundamental properties described above, and differ only in certain special characteristics to meet a variety of industrial demands.*

Applications include: Salt filter drums, oil refinery tube supports and headers, turbine nozzle rings, cylinder liners, valves and fittings, furnace rollers, textile rolls, comminuter parts, blow pit pipes, precision machine tool spindle heads, bridge, and work supports, magnet housings, sugar retorts, etc.

FULL INFORMATION

May we send you two booklets? One, entitled, "Engineering Properties and Applications of NI-RESIST," includes corrosion data on NI-RESIST and cast iron under 400 different corrosive conditions. The other, entitled, "Buyers' Guide for NI-RESIST Castings," lists producers of NI-RESIST castings. Both are yours for the asking. Write for them today.

*Reg. U. S. Pat. Off.

EMBLEM OF INCO SERVICE
TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

Recharging a Moore Rapid Lectromelt Furnace, like the size OT pictured above, is a simple, time-saving operation. You merely raise the roof hydraulically, swing it aside, then dump the scrap charge. In a mere matter of moments your Lectromelt is melting again, producing more in less time. This great reduction in down time, plus substantial labor savings, will bring your operating costs down.

Lectromelt furnaces are available in capacities ranging from 100 tons to 250 pounds. Write today for complete information.

PITTSBURGH LECTROMELT FURNACE CORP.

PITTSBURGH 30, PA.

MOORE RAPID *Lectromelt* FURNACES

manufactured in: CANADA, Lectromelt Furnaces of Canada, Ltd., Toronto 2; ENGLAND, Birlec, Ltd., Birmingham; SWEDEN, Birlec Elektkougnar A/B, Stockholm; AUSTRALIA, Birlec Ltd., Sydney; FRANCE, Stein et Roubaix, Paris; BELGIUM, S. A. Belge Stein et Roubaix, Bressoux-Liege; SPAIN, General Electrica Espanola, Bilbao; ITALY, Forni Stein, Genoa.

New Materials and Equipment

"watermark" the finish of translucent or transparent plastics, and that it contributes to producing smoother, more brilliant finishes to parts made on equipment treated with it.

New Rubber Compound Resists Dilute and Concentrated Chemicals

A rubber compound which has excellent resistance to many chemicals, both concentrated and dilute, has been announced by *Stalwart Rubber Co.*, 165 Northfield Rd., Bedford, Ohio.

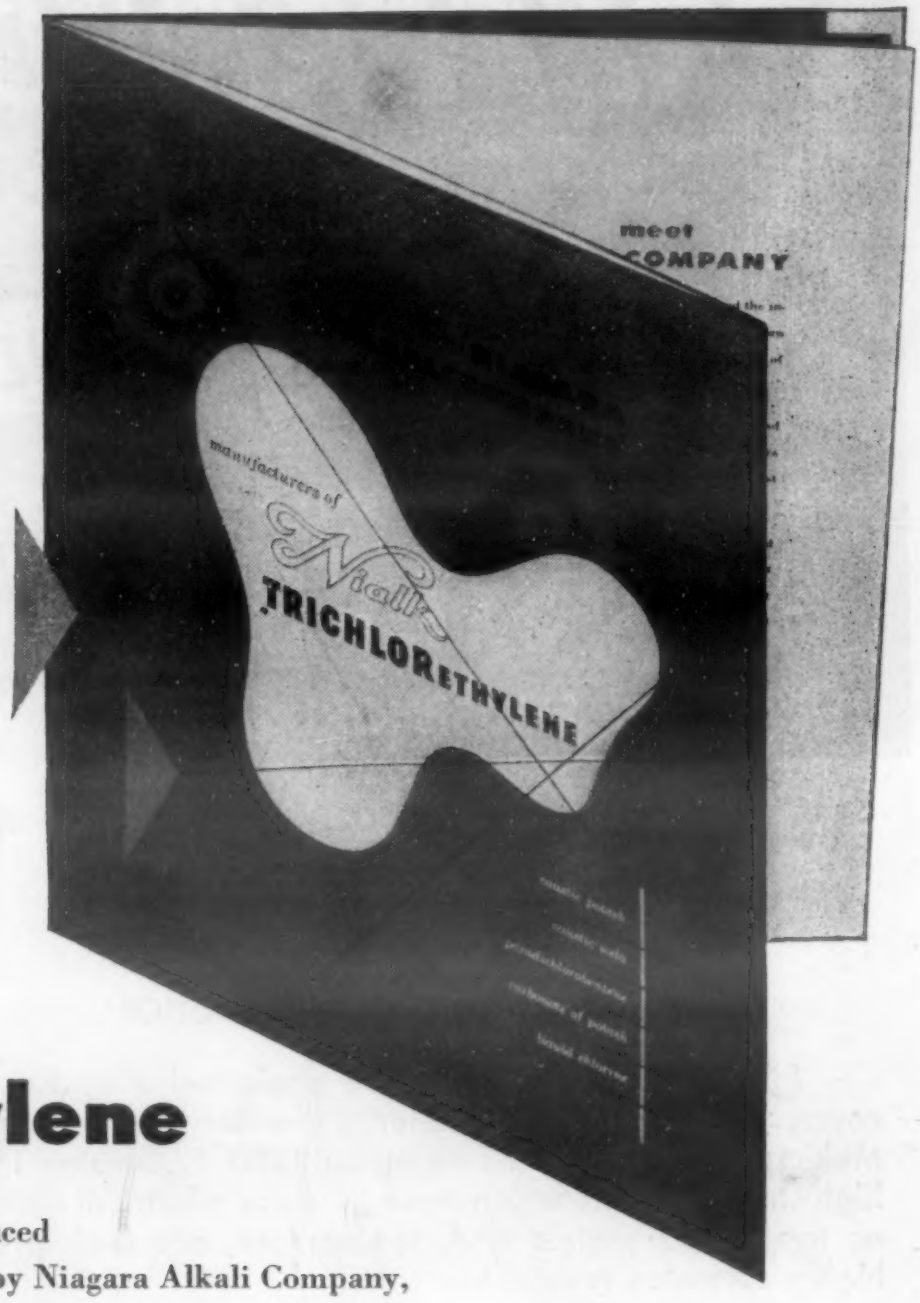
Stallite 863 withstands the action of aniline, acetone, benzene, ethyl chloride and numerous other chemicals. It is also said to have high resistance to animal fats, vegetable oils, ozone, oxygen, acids, alkalies, steam, extreme weathering, sunlight and dry heat.

Outstanding flex and abrasion resistance are claimed for the new material, and its dielectric properties make it suitable for electrical equipment of all types. Durometer hardness from 40 to 80, tensile strength up to 2000 psi., and elongation up to 500% have been obtained on parts fabricated from this rubber.

Molded, extruded and die-cut parts of Stallite 863 can be supplied for seals and stoppers for chemical containers, gaskets and washers for systems handling highly corrosive acids or alkalies, tubing and hose for installations in corrosive atmospheres or for handling dilute or concentrated chemicals, rubber stamp blanks and other parts that come into contact with all types of printing inks, and many other applications.

● An all-purpose water-soluble coolant base has been announced by *Swan-Finch Oil Corp.*, R.C.A. Bldg. West, New York 20. It is said to combine the essential qualities of a grinding compound and a sulfurized cutting oil, without their objectionable features. Designated as Safco 770 compound, the compound has the consistency of a liquid paste. It is claimed that ratios of water to base as high as 80 to 1 will prevent wheel-loading in grinding operations; reduction in wheel dressings and prevention of rust are also claimed. Safco 770 reduces the number of coolants required by most plants.

for
high
quality
and superior
stability



NIALK TRICHLORethylene

NIALK TRICHLORethylene is produced in a new plant at Niagara Falls, N. Y. by Niagara Alkali Company, one of America's pioneer chemical companies.

This new plant is completely modern and utilizes control equipment that satisfies the most exacting demands for a product of high quality and superior stability. It readily permits increased production to meet expanding demands.

WHAT YOU WANT TO KNOW about NIALK TRICHLORethylene and Niagara Alkali Company is contained in the booklet illustrated here. The coupon below will bring you a copy.

NIAGARA ALKALI COMPANY

60 East 42nd Street, New York 17, New York

Liquid Chlorine · Caustic Potash
Carbonate of Potash
Paradichlorobenzene
Caustic Soda
NIALK TRICHLORethylene

Niagara Alkali Company, Dept. F,
60 East 42nd Street, New York 17, N. Y.

Gentlemen: Please send me a copy of your booklet on NIALK TRICHLORethylene.

Name_____

Position_____

Firm_____

Street_____

City_____ State_____

PREFERRED!

FOR SILVER BRAZING OF

APW SILVALOY 15

THE SILVER PHOSPHORUS COPPER ALLOY

WHY?

- IT IS EXTRUDED IN ROUND FORM.
- IT HAS SHORTER GRAIN.
- IT HAS NO JAGGED EDGES, THEREFORE EASIER HANDLING.
- IT SPEEDS UP PRODUCTION.

Silvaloy 15 has become the preferred alloy for brazing copper, brass or bronze, either to themselves or to each other. Melting at 1185°F and flowing at 1280°F, Silvaloy 15 makes high-strength joints which have as good electrical conductivity as the joined metals and, furthermore, are leak-proof and highly corrosion resistant.

On copper, the phosphorus in Silvaloy 15 acts as a fluxing agent, so that no flux is needed. On brass and bronze, small amounts of APW flux are recommended for perfect results, although this is not always necessary. Use Silvaloy 15 for brazing copper refrigeration coils, copper electrical parts, water heaters, copper, brass and bronze tubing and pipe and innumerable other applications involving copper and copper alloys. Silvaloy 15 is supplied in extruded round wire rod, sheet, strip, wire coils, rings and special shapes.

OTHER ALLOYS MANUFACTURED BY THE AMERICAN PLATINUM WORKS

ALLOY NO.	SILVER CONTENT	MELTING POINT	FLOW POINT
SILVALOY 20	20%	1430° F	1500° F
SILVALOY 35	35%	1125° F	1295° F
SILVALOY 40	40%	1135° F	1205° F
SILVALOY 45	45%	1125° F	1145° F
SILVALOY 50	50%	1160° F	1175° F
APW 250	40%	1222° F	1416° F
APW 355	56%	1152° F	1203° F

APW No. 1100 Low Temperature Flux and APW No. 1200 Universal Flux recommended for use with these alloys.

THE AMERICAN PLATINUM WORKS

231 NEW JERSEY R. R. AVENUE NEWARK 5, N. J.

CHICAGO SALES OFFICE: 55 E. WASHINGTON STREET

DETROIT SALES OFFICE: 5151 WESSON AVENUE

New Materials and Equipment

Detection of Defects in Metals Improved by New Model Changes

Easier interpretation of test results has been made possible on a new model, Type UR, of the Reflectoscope, manufactured by *Sperry Products, Inc.*, Danbury, Conn. This model replaces the company's previous model Type SRO5.

Interpretation is aided by an improved pattern of square wave "inch markers" on the horizontal axis of the screen. A new "reject" control also gives the operator

Insignificant defects can be disregarded by this new Reflectoscope model.

additional control of sensitivity by rejecting indications of small defects which do not affect the performance of the part under test.

The Reflectoscope makes use of ultrasonic vibrations to locate defects in steel billets, forgings, castings, finished stock, and a wide variety of machined parts.

Hand-Operated Injection Press Molds Thermoplastic Materials

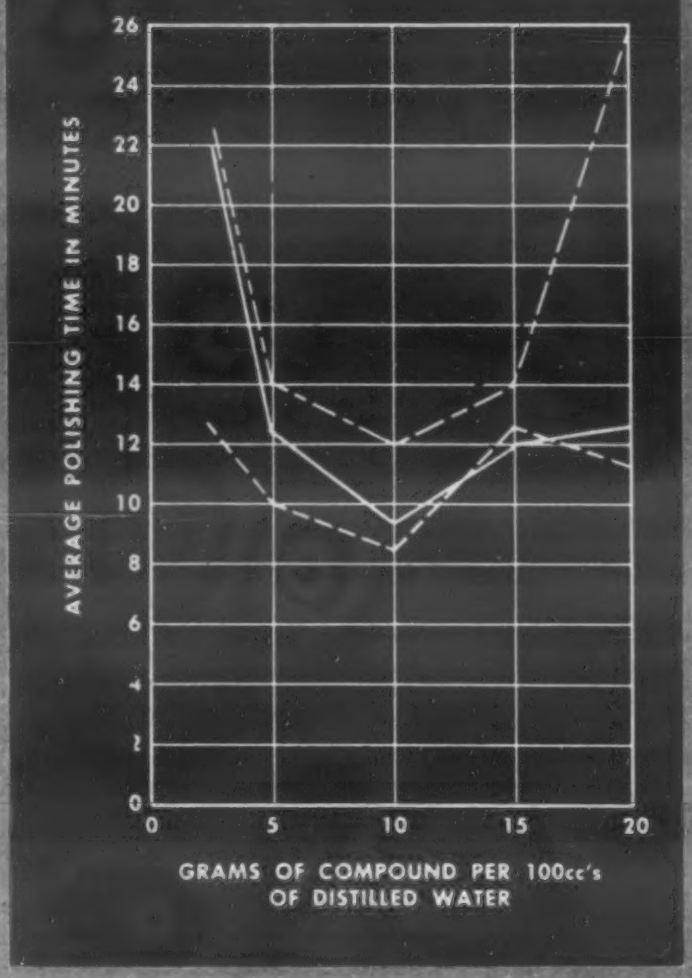
A ¼-oz. capacity, hand-operated injection molding press for thermoplastics is now being manufactured by *Plastics Development Corp.*, 225 Lafayette St., New York 12. It handles any thermoplastic moldable between 250 and 500 F. Called Plast-O-Press, the new press can be

New Glass Polishing Compound

ZIRCONIUM OXIDE

for better, faster polishing at lower cost.

EFFECT OF SLURRY CONCENTRATION ON THE POLISHING SPEED USING SPECTACLE CROWN LENSES UNDER 8 PSI WITH PITCH FELT PAD ROTATING AT 168 RPM



TAM Zirconium Oxide is producing excellent results in a variety of commercial optical glass polishing applications. Its polishing action equals highest standards attained with substantial savings in material cost and polishing time. The use of ZrO_2 contributes greatly to cleanliness . . . an important factor in precision work. Working conditions are improved through elimination of discoloration common to the use of rouge.

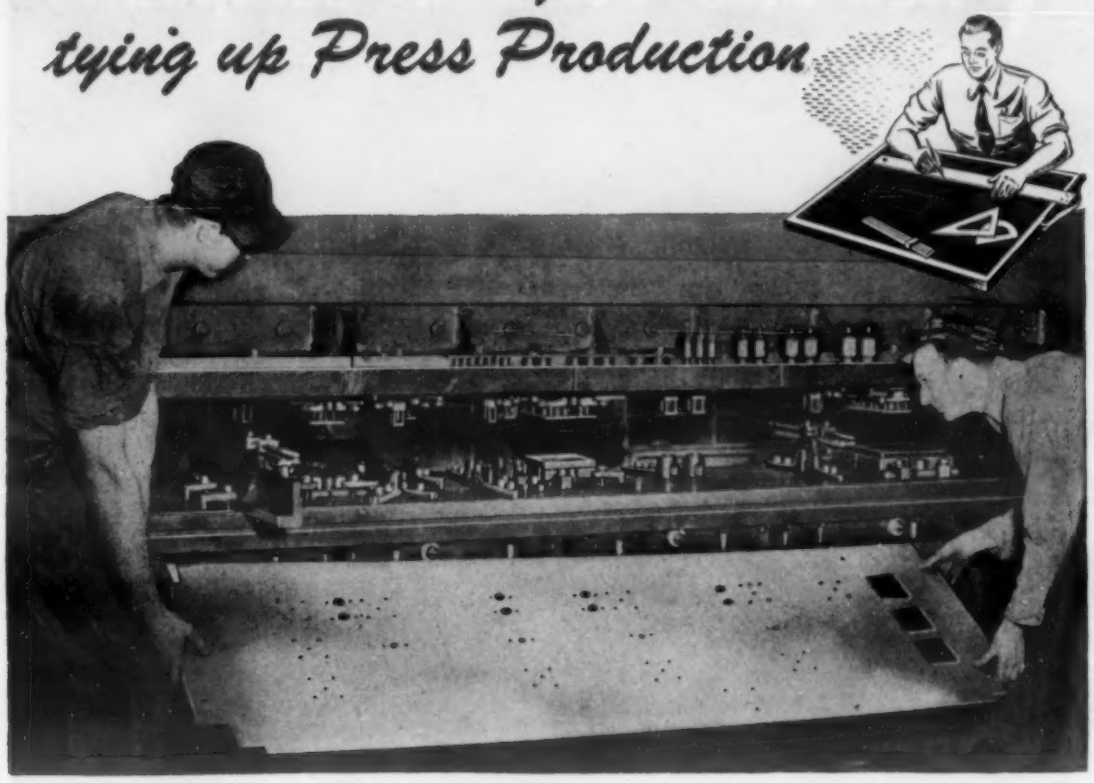
Volume production experience in optical and glassware applications substantiates all claims made for efficiency, economy and other benefits. Complete details are available upon request to our New York office.

TAM PRODUCTS
Registered U. S. Pat. Off.

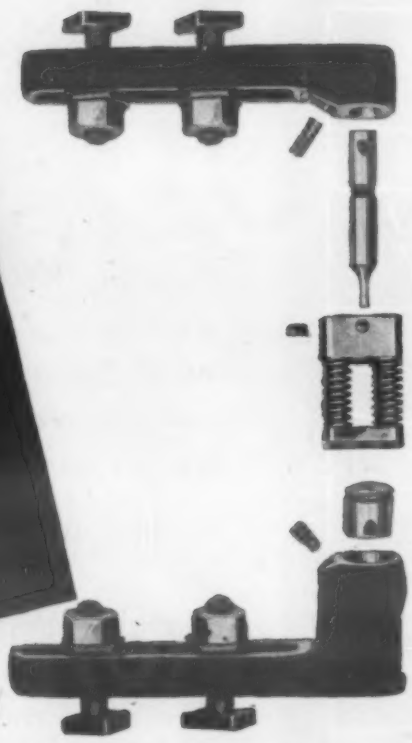
TAM is a registered trademark.

TITANIUM ALLOY MFG. DIVISION
NATIONAL LEAD COMPANY
Executive and Sales Offices: 111 BROADWAY, NEW YORK, N. Y. • General Offices and Works: NIAGARA FALLS, N. Y.

Meet sudden change-orders without tying up Press Production



WHISTLER ADJUSTABLE PERFORATING DIES quickly and easily rearranged



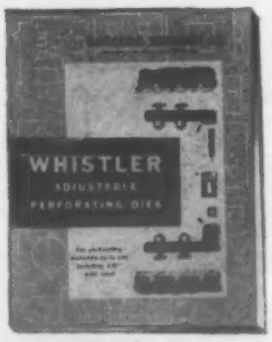
Change-orders from the engineering department usually cause plenty of headaches in production...particularly where die piercing operations are involved.

But, if you're using Whistler Adjustable Dies, there is no lost time—no waiting—no extra die expense. The same dies are easy to rearrange to the new design. Add units from stock, or delete sizes and shapes no longer required. Arrange the new set-up right on the press.

Consider the savings in production time alone. Then think how continued re-use of the same dies in subsequent jobs writes off first cost.

Whistler Dies can be used in practically any press. All parts are interchangeable. Precision is assured on long or short runs. Closer centers permit fewer press operations.

Deliveries are quick... little or no waiting. Standard round punches and dies up to 3" are available from stock. Ovals, squares, rectangles and special shapes made up in a few days.



WRITE for the Whistler Catalog today and get all the facts!

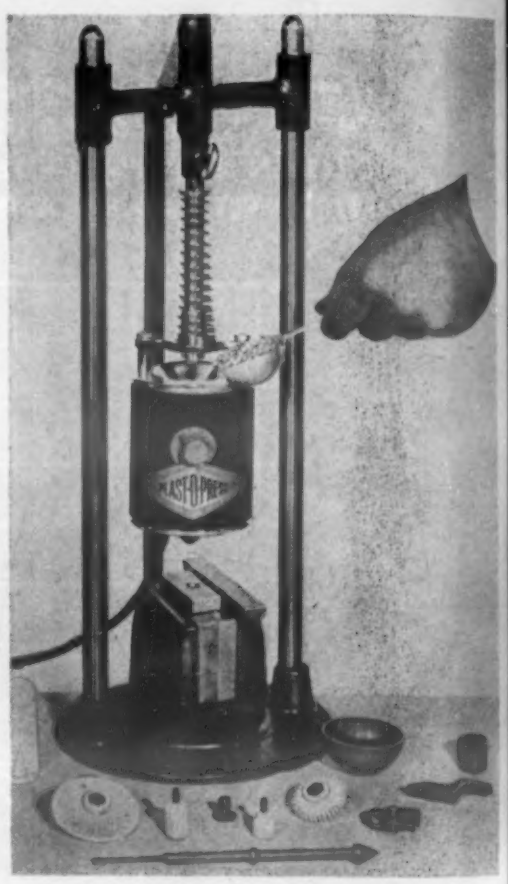
S. B. WHISTLER & SONS, INC.

756 MILITARY ROAD • BUFFALO 17, NEW YORK

New Materials and Equipment

chucked into any drill press or used with an arbor press specially designed for it.

The low-cost press is reported to be well adapted to experimental, test, sample and short-run molding of plastic compon-

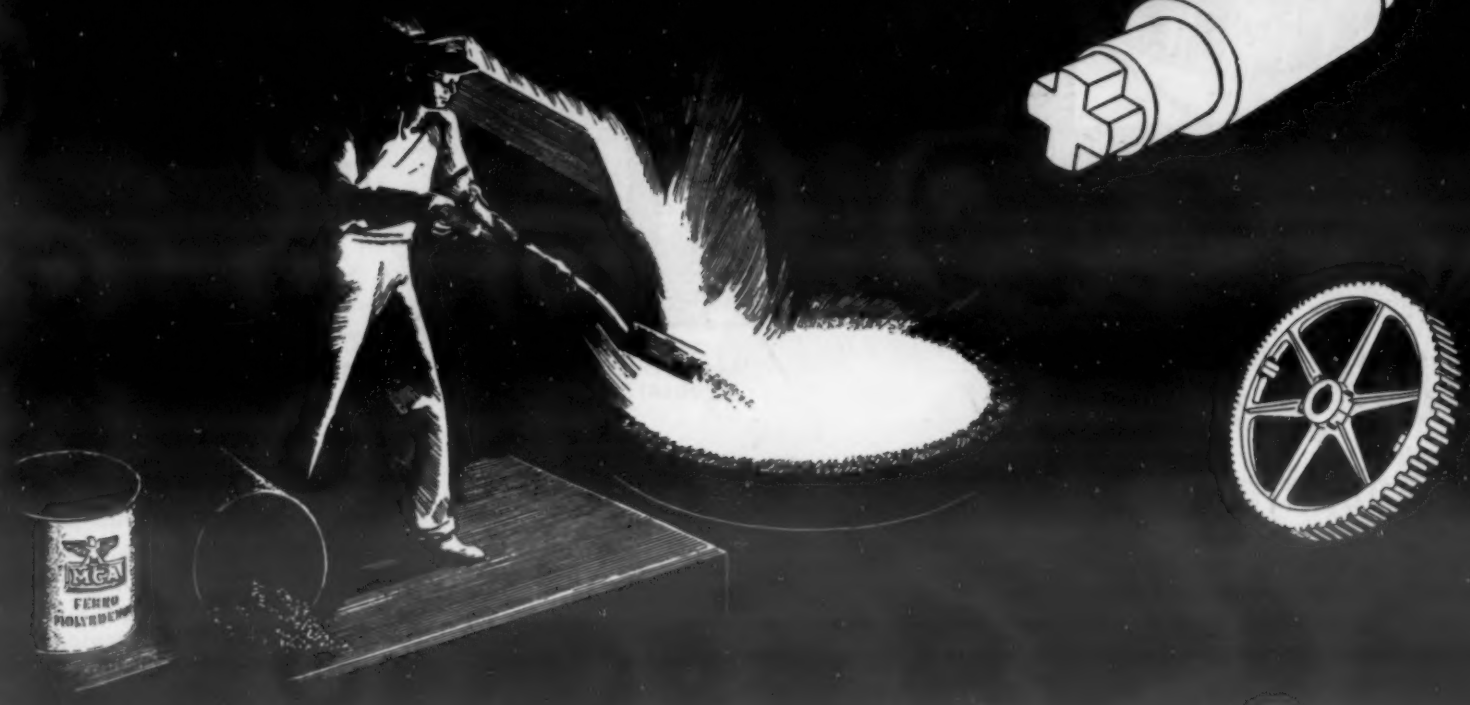


The Plasto-O-Press is designed for experimental, sample and short-run molding between 250 and 500 F.

ent parts or products within its capacity. The simple hand operation of the press requires no training or experience to turn out better than one molded piece per minute. The new press is said to be more economical than previous methods of doing the same work.

● A new model tester, designed to perform the brittle point test (A.S.T.M. Designation D746) on vulcanized rubber and other elastomers, has been developed by the Research Laboratory of the *American Cyanamid & Chemical Co.* and is being produced by *Scott Testers, Inc.*, Providence, R. I. Compact and lightweight, this portable machine, Model E, operates on a solenoid-actuated guillotine principle with the prescribed standard test piece. Unusually quiet operation is claimed.

. . . in the foundry also



things are changing!

Progress means change, in the foundry as elsewhere. Competition sets the pace. Many light and heavy castings made for machine parts and various other uses, now have to compete with different methods of manufacture. Skills, judgment, and readiness to take advantage of new knowledge are demanded at such a time. A foundryman who is aware of the challenge needs to be well acquainted with the benefits of Molybdenum, Tungsten, and Boron in making better, stronger cast irons and steels.

The Molybdenum Corporation offers literature and employs a technical staff that can perhaps be helpful. Correspondence is invited.

MCA

AMERICAN Production, American Distribution, American Control, Completely Integrated.

Offices: Pittsburgh, New York, Chicago, Cleveland, Detroit, Los Angeles, San Francisco, Seattle.

Sales Representatives: American Steel and Supply Co., Chicago; Edgar L. Fink, Detroit, Brumley-Donaldson Co., Los Angeles, San Francisco, Seattle.

Subsidiaries: Cleveland-Tungsten, Inc., Cleveland, O.; General Tungsten Manufacturing Co., Inc., Union City, N. J.

Works: Washington, Pa.; York, Pa.

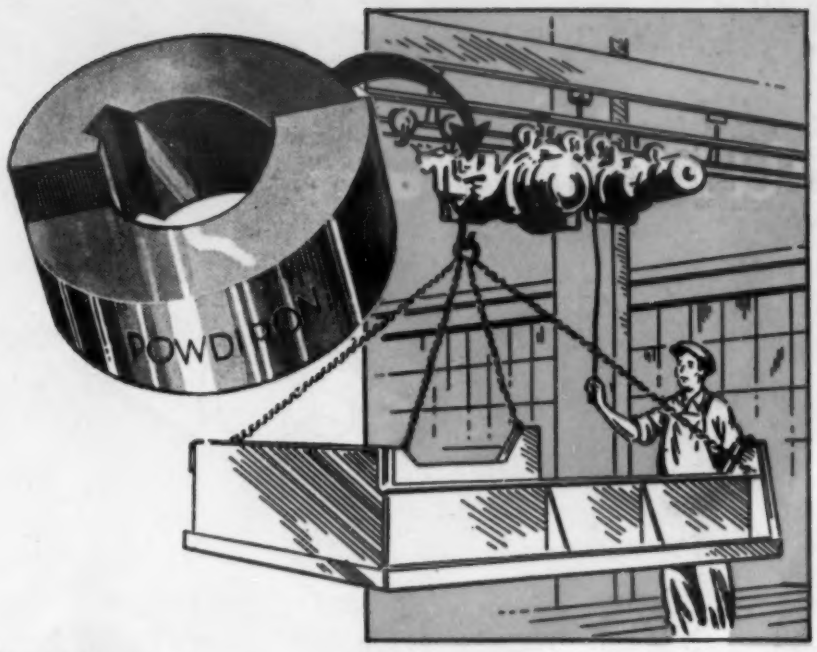
Mines: Questa, New Mexico; Urad, Colorado.

MOLYBDENUM

CORPORATION OF AMERICA

GRANT BUILDING PITTSBURGH, PA.

MCA



*NAME ON REQUEST.

Why a Prominent Industrial Equipment Manufacturer* Switched to "POWDIRON" For a CRITICAL CHAIN HOIST PART

Adopting this hoist brake cam, produced by Bound Brook from "POWDIRON" (Sintered Iron) to accurate finished dimensions, ready for assembly, has meant:

- *Elimination of costly, time-consuming machining operations—"POWDIRON" assures an accurate fit.*
- *Continuous lubrication on cam surfaces.*
- *Full required strength for long-time service on tough jobs.*
- *Smooth, sure, safe operation.*

"POWDIRON" has proved to be the perfect material for many heavy-duty bearings, and structural parts such as gears, cams, sockets, pole pieces, levers, etc. Made of pure metal powders, "POWDIRON" parts and bearings are die-formed to accurate dimensions and sintered at high temperatures. Simple or intricate shapes can be produced in quantity to close tolerances. When needed, "POWDIRON" parts and bearings can be vacuum-impregnated with lubricant to give thousands of trouble-free operating hours, without further need of lubrication.

"POWDIRON" SINTERED IRON BEARINGS AND STRUCTURAL PARTS

Consult our engineers on your requirements for structural parts and bearings. *We've saved time and costs for others; we can do the same for you.*

Structural parts are made to your specifications. Bearings in thousands of sizes can be quickly made from dies on hand. Mail coupon below for free copy of our "Powdiron" Data Sheet.

BOUND BROOK OIL-LESS BEARING COMPANY

BEARINGS • BUSHINGS WASHERS • PARTS

BOUND BROOK, N. J. ESTABLISHED 1883

Bound Brook Oil-Less Bearing Co. MM 12-49
Bound Brook, N. J.

☐ I would like to talk to one of your engineers about _____

_____

☐ Please send me a copy of your "POWDIRON" Data Sheet.

Name _____ Title _____

Company _____

Street _____ City _____ State _____

New Materials and Equipment

Permanent Magnet Marketed as Grounding Clamp for Welder

A permanent Alnico magnet designed to serve as a clamp for the ground cable on electric welders is now being marketed by *Dings Magnetic Separator Co.*, 4740 W. Electric Ave., Milwaukee 14, Wis.

The MagnaGround takes up to 600 amp. and is claimed to reduce amperage needed by providing a positive ground. It is easily attached to the cable with set screws or silver soldering, and it can be applied and held fast to any magnetic surface, vertical or horizontal. The unit can also be used as a holding or welding fixture.

● An improved furnace retort featuring a rigid one-piece bottom seal ring has been announced by *Stanwood Corp.*, 4819 Cortland St., Chicago 39, Ill. The ring will hold its shape throughout the life of the retort, assuring a tight seal and easy installation or removal from the furnace. Nickel-chromium alloys are used throughout.

Large Castings, Forgings Cleaned in Airless Shotblasting Room

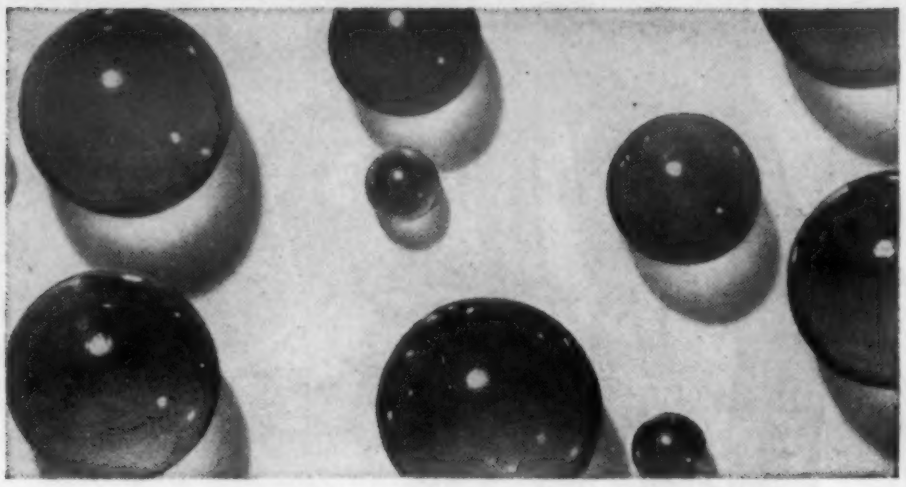
A Rotoblast Room providing airless, centrifugal-type blast cleaning for large castings, forging or fabrications, is being manufactured by *Pangborn Corp.*, Hagerstown, Md.

The rubber-lined steel blast rooms, available in varying sizes, are served by two standard Rotoblast units and an abrasive separator which cleans the metal abrasive and returns it to the Rotoblast units for reuse. Loading and unloading of large castings is facilitated by a power-driven blast room car which enters the blastroom on its own track through 12½-ft. doors; it is equipped with a revolving work table 10 ft. in dia. which is turned mechanically by means of contact with a friction wheel and revolves at adjustable speeds up to 1½ rpm., exposing all sides of the work to the blast stream impact.

The Rotoblast Room is said to provide

(Continued on page 118)

Oilfoil
From the name you would guess that Oilfoil keeps oil in or out. Correct. But it not only acts as a positive seal. It also is a storage reservoir for oil, which bleeds out as required for bearing lubrication. Further, it is an impervious shield against water, dirt, other foreign matter.
How is this accomplished? An Oilfoil washer or seal is a sandwich of felt and Hycar, the synthetic elastomer that is especially resistant to hydrocarbons. The felt may be of the same type and density throughout, or different felts may be combined with one or more impervious septums, according to the requirements of the specific case. Oilfoil Seals or Washers are usually impregnated with oil, grease, graphite or other lubricants before assembly.
Originally developed by us in 1921, these laminated felt seals are now being increasingly recognized as offering the ultimate in protection. Write for full information.
American Felt Company
TRADE MARK
GENERAL OFFICES: 24 GLENVILLE ROAD GLENVILLE, CONN.
Engineering and Research Laboratories: Glenville, Conn.
PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich., Westerly, R. I.
Sales Offices: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal



Now PRECISION BALLS *of Synthetic Sapphire*

Now . . . the wear, corrosion, and heat resistance of synthetic sapphire in balls polished to within 20 micro-inches of sphericity.

THESE unicrystalline spheres resist corrosion or erosion by many acids and alkalis . . . possess a higher dielectric strength than glass or mica . . . have a low coefficient of friction and superior hardness. In many applications, they need not be lubricated.

LINDE synthetic sapphire balls are available in 1mm, 1/16 inch, 1/8 inch, and 1/4 inch sizes. Three surface finishes are available: super-finished, semi-finished, and rough-ground blanks.

CALL or WRITE any LINDE office for information on these balls, or the other forms of LINDE synthetic sapphire.

PROPERTIES

Composition	Al_2O_3
Coefficient of Friction (Steel pivot on sapphire ring)	0.140
Hardness (Knoop)	1525—2,000
Modulus of Elasticity in Flexure	50—56 x 10^6 psi
Dielectric Constant	7.5—10
Modulus of Rigidity	21.5—27.5 x 10^6 psi
Thermal Coefficient of Expansion up to 50°C (per °C x 10^{-6})	5.0—6.7
Chemical Resistance	Unaffected by acids, dilute alkali.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: THE DOMINION OXYGEN COMPANY, LIMITED, Toronto

The term "Linde" is a trade-mark of The Linde Air Products Company

New Materials and Equipment

faster, better cleaning and cut costs becau it requires about one-third the man-hou necessary in previous installations. A sing man can run the entire cleaning room an since he remains outside, the need f

A car with a revolving table is used t load the Rotoblast Room and assure impa on all exterior surfaces of the work.

protective clothing and air-fed helmets i eliminated.

This new installation has been used t clean work weighing 1 lb. to 1 ton. Whe castings contain long hollow areas impo sible to reach with any kind of automati cleaning, the room-type structure mak any necessary airblast operations convenien

● A light-weight, portable spot welde named "Big Shot" has been announced b *Tool & Equipment Distributors,* 636 S 10 Ave., La Grange, Ill. The 110-v. uni is said to weld readily two sheets of 20- u 18-gage steel, galvanized iron, Monel an Hoskins alloys, and somewhat thicker stain less steel. The 220-v. unit welds steel up to 1/8-in. thick.

Die Casting Machine Can Be Used as Cold-Chamber or Gooseneck Type

A new die casting machine, Model 50 has been developed by *Cleveland Auto matic Machine Co.,* 4932 Beech St., Cin cinnati 12, Ohio, to produce aluminum castings up to 2½ lb. and zinc castings up to 4 lb.

Although actual production rate of any casting is dependent upon the complexity and size of the casting itself, free cycle time of the machine is well over 1000

Only Magnesium-Light is light enough"

You'll hear this said often about Dow

MAGNESIUM

the world's lightest structural metal!

With the value of lightness emphasized by constantly rising costs, operators in the motor transport field want more than just lightweight equipment—they want equipment that is *magnesium-light.* These men who use everything from small panel trucks to huge trailers know that only with magnesium can maximum lightness be achieved.

Magnesium is strong and durable and yet is a full one-third lighter than any other structural metal. This bonus—this premium of one-third greater lightness—makes possible significant weight savings which are immediately reflected in increased payload and decreased operating and maintenance costs. A properly designed magnesium body is frequently 20-25% lighter than the same size body built with other light metals.

This is just one of the fields where magnesium increases efficiency by cutting dead weight to a minimum. It will pay you to investigate magnesium lightness when designing your product. For case studies on successful uses of magnesium, send for "How Magnesium Pays."

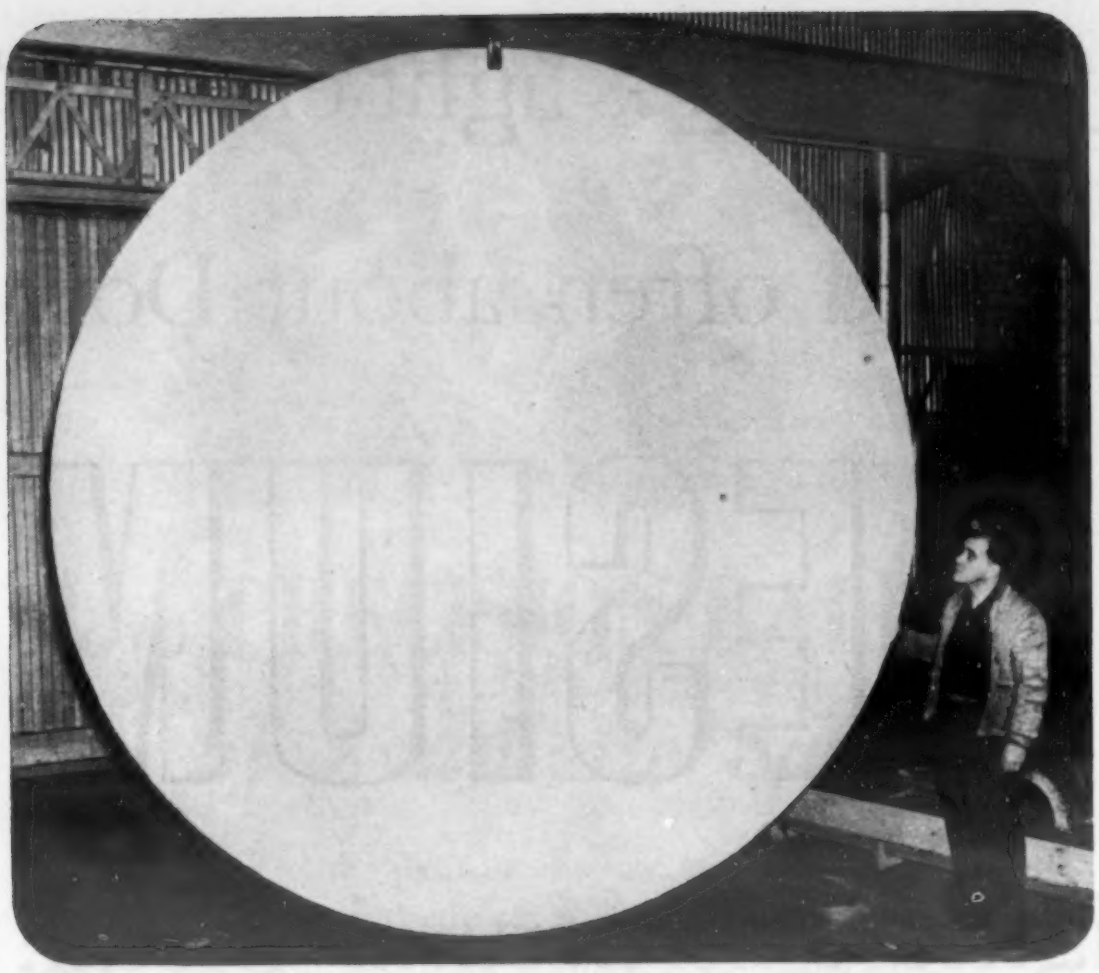
Get maximum weight reduction— Use Magnesium Extrusions

Magnesium extrusions can give you significant weight reductions without the loss of needed strength and rigidity. Often, the use of magnesium extrusions tailored to your particular needs will cut manufacturing costs by eliminating the necessity of forming or fabricating from standard shapes. They are competitively priced and available in rods, bars, and tubes as well as structural shapes conforming closely to American Standard Sections.

Lighter Products Sell—make your product Magnesium Light!

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston
San Francisco • Los Angeles • Seattle • Dow Chemical of Canada, Limited, Toronto, Canada



Are you going around in

STAINLESS CIRCLES?

Cutting Stainless Steel to shape is easy—when you have the proper equipment.

G. O. Carlson, Inc. regularly supplies diameters from our own plate in sizes ranging from less than one inch to the world's largest —to your precise specifications, in any thickness.

You usually save money and time by ordering diameters, circles, rings, and heads from G. O. Carlson, Inc. Highly specialized cutting facilities for Stainless Steel have been developed at our plant to handle a wide range of requirements. Why not take advantage of our equipment?

Send us your next order for stainless steel diameters—produced from plate to chemical industry standards, cut to your order ready to use.

G. O. CARLSON, INC.

Stainless Steels Exclusively

200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

District sales offices and warehouse distributors in principal cities

New Materials and Equipment

shots per hr. The machine can be furnished either as a cold chamber outfit for casting aluminum or as a gooseneck type unit for casting zinc, tin or lead. Rapid changing of either setup is possible.

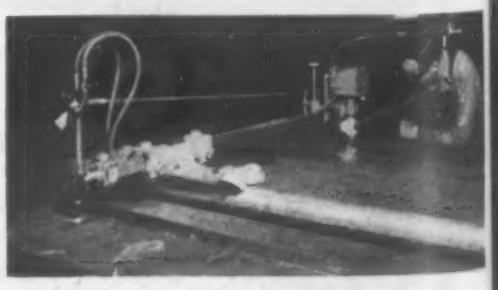
Model 50 is a high pressure hydraulic machine, equipped with a Vickers two-stage pump driven by a 10-hp. direct-connected motor. The pump delivers 43 gal. per min. at the low pressure stage and 10½ gal. per min. at the high pressure (500 psi.) stage. The hydraulic system includes Vickers oil fitters, a heat exchanger, and a 70-gal. capacity oil reservoir.

The new machine has die plates 22 by 18 in. and four tie bars 2 in. in dia. Space between tie bars is 16 by 12 in., and die opening is 8 in. An estimated 50-ton locking pressure is obtained through a toggle mechanism. Either automatic or manual controls can be supplied.

Shape-Cutting Machine Is Priced Within Range of Small Shop

Air Reduction Sales Co., 60 E. 42 St., New York 17, has announced production of a new portable oxyacetylene shape-cutting machine known as the Airco No. 3 Monograph. The new model is claimed to be the lowest price machine of its type on the market, and it is intended to make machine gas cutting feasible in small shops.

The Monograph will cut steel up to 8 in. thick in any shape within a 54- by 32-in. area at speeds from 3 to 30 in. per min.



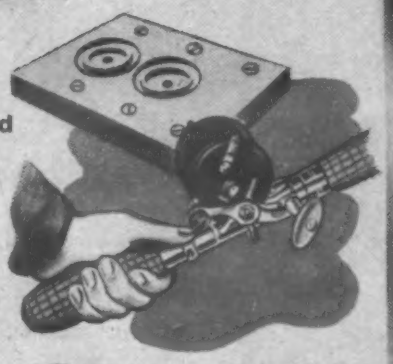
The Airco Monograph will cut steel up to 8 in. thick in any shape within a 54- by 32-in. area.

The length of the cutting area can be extended by adding tubular rail extensions. In addition to any shape desired, the machine is also claimed to handle straight-line, circle and bevel cutting jobs with high accuracy. Weight of the machine is 110 lb.

MOLDED IN PLASTICS BY GENERAL ELECTRIC

Paper cup dispenser, molded by General Electric for the Dixie Cup Company, Easton, Pa.

LOWER SELLING PRICE! The use of G-E plastics (instead of wood) for this television cabinet helps to make possible a low-priced set.



LARGE-VOLUME JOBS! G. E. is ideally equipped to mold large-quantity jobs—like parts for the Ocean City Manufacturing Co.'s surf casting reel.

PLASTICS FOR DISPLAY! The attractive housing of this Spur syrup dispenser was molded by G. E. for Canada Dry.

Plastics

How G-E Plastics Help to LOWER PRODUCT COSTS

Here's an excellent example of how General Electric's plastics molding service helped to achieve improved design and *low costs* on a large-volume job.

G. E.'s customer, the Dixie Cup Company, wanted an attractive cup holder—sanitary, durable, yet inexpensive enough to be sold for home as well as office use. They got it! General Electric molded this cleverly-designed unit of crystal-clear polystyrene; no metal dispensing parts are needed. And low-cost production made possible a low retail price which is attracting thousands of customers.

For low cost and high quality depend on General Electric's plastics service! One of the world's largest plastics molders, G. E. is ideally equipped for large-volume production. WRITE US FOR MORE INFORMATION on how this service can work for you. Or contact your nearest G-E sales office. Address: Plastics Division, Chemical Department, General Electric Company, 1 Plastics Avenue, Pittsfield, Mass.

GENERAL ELECTRIC

CD49-A44

General Electric plastics factories are located in Coshocton, Ohio; Decatur, Ill.; Taunton and Pittsfield, Mass.

. SAVE ON MACHINING .

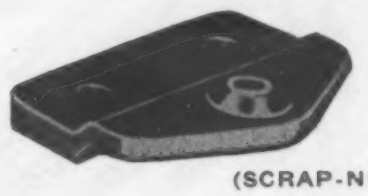
. SAVE ON ASSEMBLY .

. SAVE ON SCRAP .

REDESIGN FOR POWDER METALLURGICAL PROCESSING!

ONE PART • NO ASSEMBLY

1. PRESS
2. SINTER
3. OIL IMPREGNATE



(SCRAP-NIL)

REPLACES

FOUR PARTS • ONE ASSEMBLY

SCREW MACHINE SCRAP—50 PERCENT
BLANKING SCRAP—42 PERCENT

(Courtesy LIONEL CORP.)

CALL IN YOUR COMPACTED PARTS FABRICATOR FOR DESIGN CONSULTATION

EKSTRAND & THOLAND, Inc.

441 Lexington Ave.

New York, 17, N. Y.

Sellers of HOEGANAES Sponge Iron Powder

New Materials and Equipment

Acrylic Molding Powder Designed for Low Temperature Service

A new soft-flow acrylic molding powder designed for molded parts, where high service temperatures are not required, has been announced by *Rohm & Hass Co.*, Washington Square, Philadelphia 5, Pa.

Plexiglass VS is said to offer exceptional moldability combined with water-white clarity equal to that of the heat resistant "V" and medium-flow "VM" molding powders. Lower molding temperatures and possible faster cycling are expected as a result of its ease of working. Addition of soft-flow VS completes this company's line of "V" grade injection powders.

Physical and chemical properties of the new molding powder are similar to those of medium-flow VM. The material has a specific gravity of 1.18 and refractive index of 1.49. Its heat distortion temperature under standard A.S.T.M. test is 151 F compared with 174 F for Plexiglas VM.

● A universal rust preventive for metals, Rustarest No. 30, is being marketed by *International Rustproof Corp.*, 12507 Plover Ave., Cleveland, Ohio. This clear, transparent coating dries quickly without baking and will not chip or crack under any normal fabricating application. It is claimed to expand and contract with the metal under all conditions. Principal use is expected to be preventing corrosion of parts during long shipments or storage.

Automatic Soldering Machine Uses Induction Heating Coil

An automatic soldering machine which uses an induction heating coil to produce fast clean soldering is being manufactured by *Sherman Industrial Electronics Co.*, 505 Washington Ave., Belleville 9, N. J. Work capacity of the new machine is approximately 1000 pieces per hr., although the actual rate depends upon the gage metal to be soldered and upon the area to be heated.

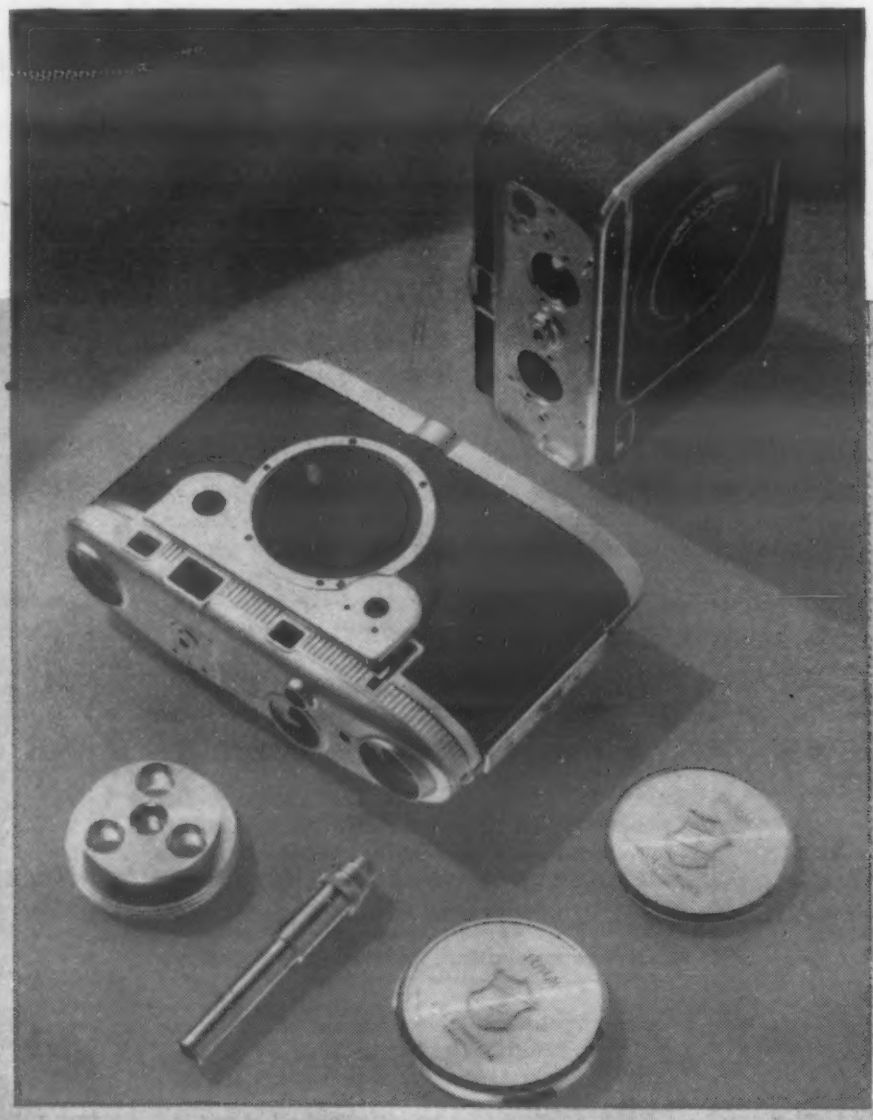
The mechanism consists of a travelling set of stainless steel fingers arranged to

plated finishes, for example

Make a few changes in your plating procedures and you're set to plate bright chrome or any other metal on aluminum. Good platers quickly master the simple changes necessary in surface preparation.

Alcoa Aluminum takes plated, painted, chemical and mechanical finishes. Only aluminum offers the patented Alumilite and Alrok finishes that seal color *in* the metal surface.

Alcoa's Laboratories have been developing finishes for aluminum for half a century. Bring your finishing questions to the company that knows aluminum best. Ask your nearby Alcoa Sales Office for a copy of the book, "Finishes for Alcoa Aluminum" or write ALUMINUM COMPANY OF AMERICA, 662M Gulf Building, Pittsburgh 19, Pennsylvania.



Camera parts courtesy of Bell & Howell

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METAL *Spinning*

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Complete facilities for sheet metal working and spinning of all metals — including stainless steel — are available at Teiner. Blanks ranging in diameter from up to 16 feet to the size of a thimble may be spun to meet tolerances formerly limited to other methods. Designs regularly in production at Teiner include stainless steel shrouds, aluminum reflectors, metal hemispheres, guards, baffles, parabolic shapes, flanged and dished heads. Estimates prepared promptly from your samples or drawings — consult Teiner and save time and money.

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INDUCTION HEAT

PERMITS 2 OZ. TOLERANCE

ON HIGH SPEED
FORGING PRESS

It previously took 8 to 10 drops of a hammer, with slow flow of metal, to achieve close tolerances required for connecting rod forgings. But this leading automobile plant recently combined scale-free, closely controlled Ajax-Northrup heat with improved die design, and pioneered the development of rods *press-forged* at unheard-of production rates.

Clean, fast induction heat now saves tons of steel yearly in many forge shops. Increases die life as much as 20%. No abrasive scale, and accurate timing prevents overheated dies. A bank of Ajax-Northrup heaters at each machine handles several sizes of stock, heating variable lengths with quickly adjustable timing and feeding devices so that jobs can be changed in a jiffy. Saves start-up time; the first hot billet is ready in seconds. No need to "pull" stock during shut-downs—just push the "off" button instead. Working conditions are better, too.

Whether you want to improve quality or reduce costs, you'll find the right answer in Ajax-Northrup. Over 33 years experience in successful induction heating and melting.

AJAX
ELECTROTHERMIC
CORPORATION

AJAX PARK, TRENTON 5, N. J.

Associate Companies
THE AJAX METAL COMPANY • AJAX ELECTRIC FURNACE CORPORATION
AJAX ELECTRIC COMPANY, INC. • AJAX ENGINEERING CORPORATION

SINCE 1916

AJAX NORTHRUP
HEATING & MELTING

1195

New Materials and Equipment

push the parts to be soldered along a V type track over an induction heating co which melts the solder. A shallow wate trough sets the solder just before the

Pictured here is a Sieco soldering ma chine being used to join paint brush fe rules.

pieces drop through an exit hole at the extreme right edge of the work table. The soldering heat is supplied by a 1-kw.-out put, Sieco Type SI-1 induction heater.

● A new electric muffle furnace for hard ening, annealing, drawing and other hea treating applications in the toolroom and production shop is being manufactured by *Wesgo,* 589 Bryant St., San Francisco, Calif. The furnace operates at a maximum temperature of 2000 F on 110- or 220-v. a.c., and has a muffle size of 4½ in. high, 6½ in. wide and 11 in. deep. Automatic temperature control is provided.

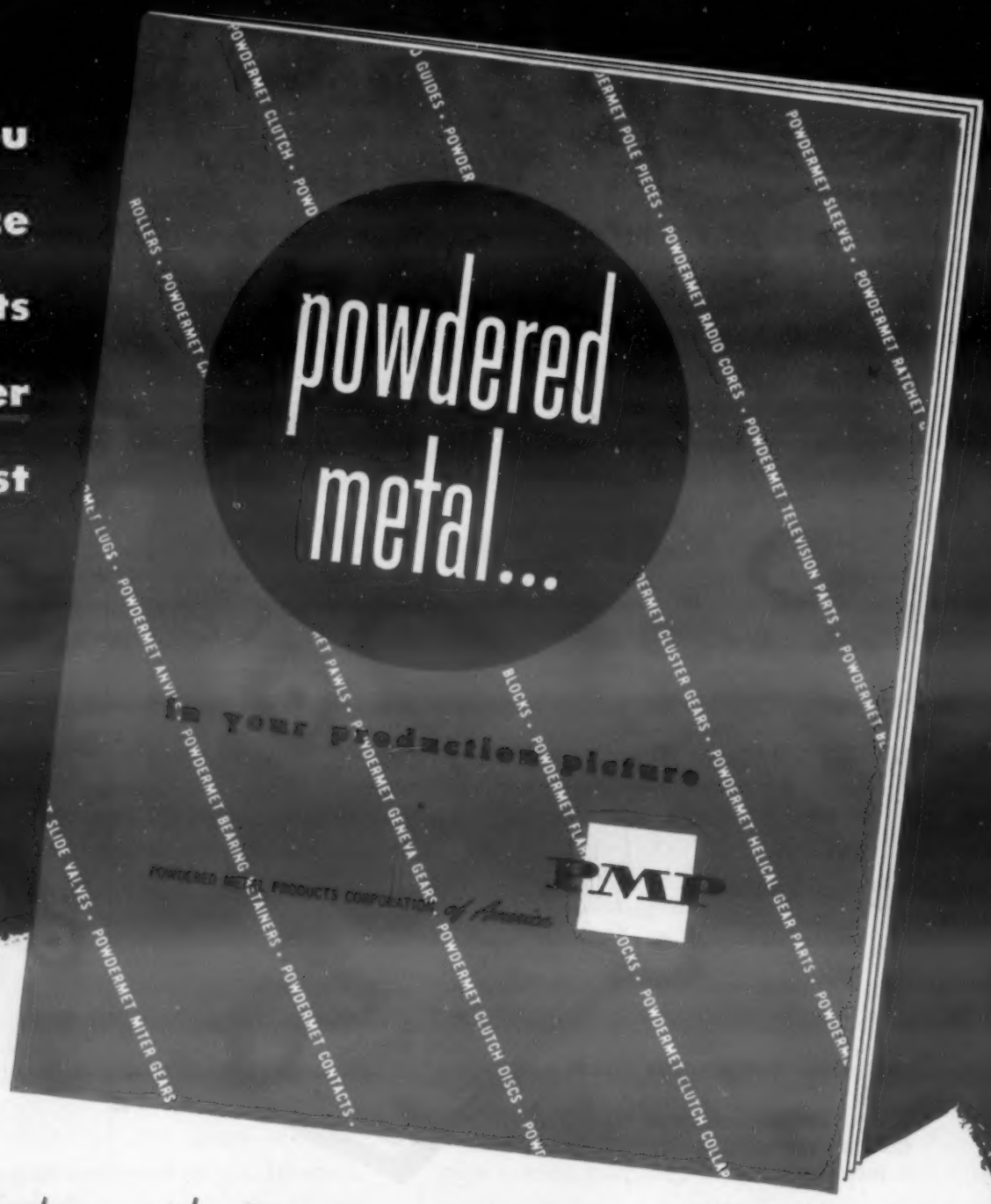
Changes in Press Design Follow Recent Adoption of New Standards

A complete new series of standard presses having capacities of 100, 150 and 200 tons has been announced by *Lake Erie Engineering Corp.*, Buffalo, N. Y.

Standardization in this field is being accomplished as a result of agreements reached by the recent Joint Industry Conference, and it is resulting in lower costs for press manufacturers.

The Lake Erie presses have been designed to meet a demand for low cost,

to help you produce better products at lower cost


powdered metal...
in your production picture
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POWDERED METAL PRODUCTS CORPORATION of America
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Check the latest developments in powder metallurgy . . . improvements that lead to whole new fields of application for *Powdermet** parts. The new *Powdermet* process, copper filling, permits economical production of previously "impossible" parts and results in unit strengths approaching those of mild steel! See how *Powdermet* parts can work for you. Send for your free copy of "Powdered Metal In Your Production Picture" now!

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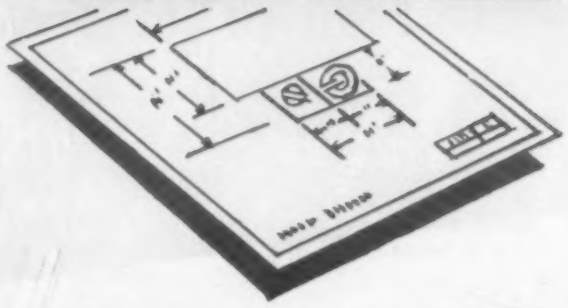
TOP PERFORMANCE WITH AJAX TAMA-WYATT

INDUCTION FURNACES for Aluminum Alloys

Ajax Induction Holding Furnace at Mid-Western Die Casting Co., Chicago, Illinois.



BETTER PRODUCTION THROUGH TOP PERFORMANCE IS THE AJAX RECORD

Ajax-Tama-Wyatt induction furnaces are used in the United States and abroad for melting and holding aluminum alloys in die casting, permanent mold, and sand foundries.

No flux or mechanical stirring is necessary. The metal is in constant gentle circulation assuring complete blending of alloys, and a uniform temperature throughout the metal.

Electric energy costs less than fuel and avoids danger of overheating. Completely automatic temperature controls hold metal to within 5°F., at the lowest possible temperature for perfect casting. With an Ajax the yield for perfect castings is exceptionally high.

There are no fumes and operation is practically noiseless. Shops are cooler, more comfortable — manpower efficiency is increased. Shop space is increased, for an Ajax Holding Furnace takes an average of 30 to 40 percent less floor space than any other furnace.

The Ajax companies have been pioneers in induction melting of metals since the first World War. To date they have installed more than 400,000 KW. of furnace capacity in the United States alone. This is the background of experience behind every Ajax installation.

AJAX ENGINEERING CORPORATION · Trenton 7, New Jersey

AJAX TAMA-WYATT INDUCTION MELTING FURNACE

Associate Companies: AJAX METAL COMPANY, Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORP., Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

New Materials and Equipment

single-action, utility and forming presses with or without hydro-pneumatic cushion. They are used for drawing, forming, straightening, bending, coining and other shop operations.

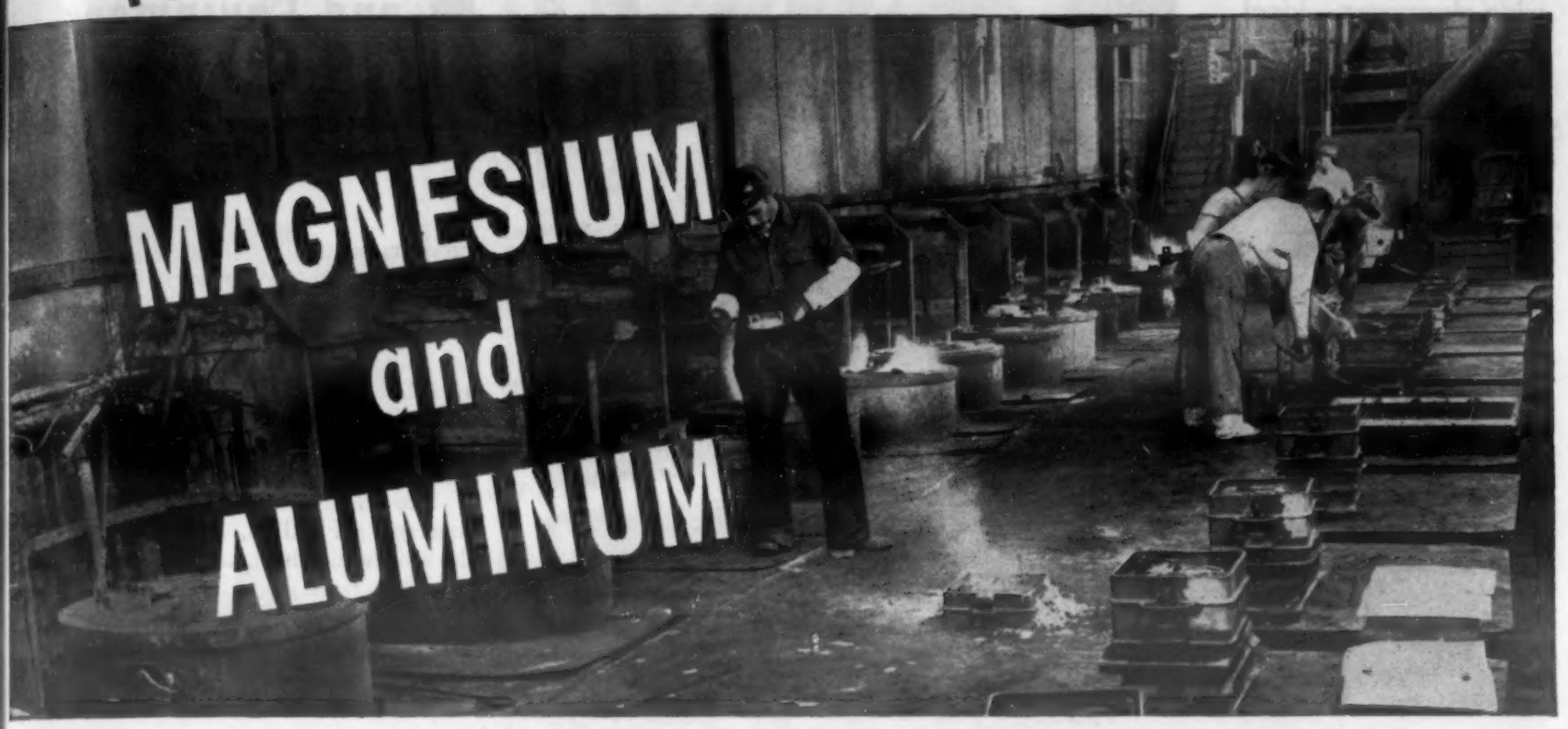
The presses, in each tonnage, can be furnished in four combinations—(1) single-action normal-speed, with hand-lever operation; (2) single action with cushion, normal-speed, hand-lever operation; (3) single-action with high-speed push button operation; and (4) single-action with cushion, high-speed push-button operation.

Pictured here is one of the new line of standardized presses manufactured by Lake Erie Engineering Corp.

Corrosion-Resistant Metal Finish Also Serves as Good Paint Base

Iridite No. 8—Hue Brite, an all-purpose metal finish designed for plated, galvanized or die cast parts, has been developed recently by *Allied Research Products, Inc.*, Baltimore, Md. A chromate-type finish, Iridite No. 8 is expected to find wide use among manufacturers of parts or assemblies

For Basically Better Castings . . .



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Foundries

From the complete metallurgical and X-ray laboratories to the final inspection before shipment, every department in the Eclipse-Pioneer Division Foundries employs the most modern techniques and testing devices available. In addition, every phase of production is conveyorized and mechanized for more economical and efficient handling of materials—a feature which is reflected in the reduced cost of the fine quality castings. During more than nineteen years of experience with difficult casting problems, the Eclipse-Pioneer Division Foundries have produced such diversified items as all-cast parts of the lightest known lawn mower, lightweight hand power tools and aircraft gun turret gimbals. For more detailed information send for Eclipse-Pioneer's illustrated Book of Facts today.

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- **PERMANENT MOLD CASTINGS**
- **DIE CASTINGS**

PLEASE SEND ME THE ECLIPSE-PIONEER "*BOOK OF FACTS*" ON MAGNESIUM, ALUMINUM AND BRONZE CASTINGS.

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ECLIPSE-PIONEER DIVISION FOUNDRIES
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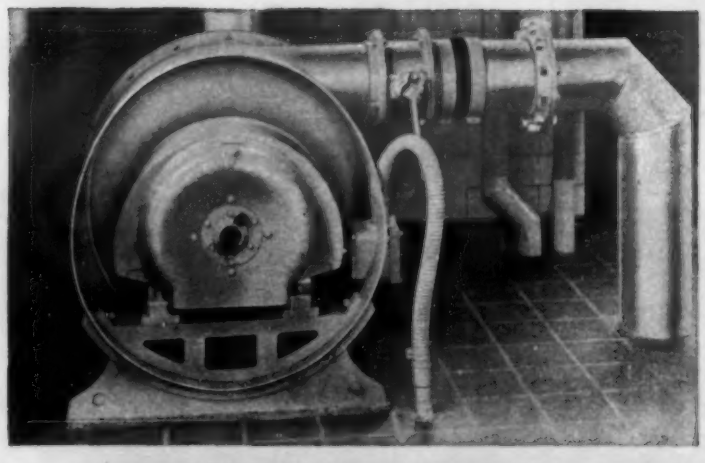
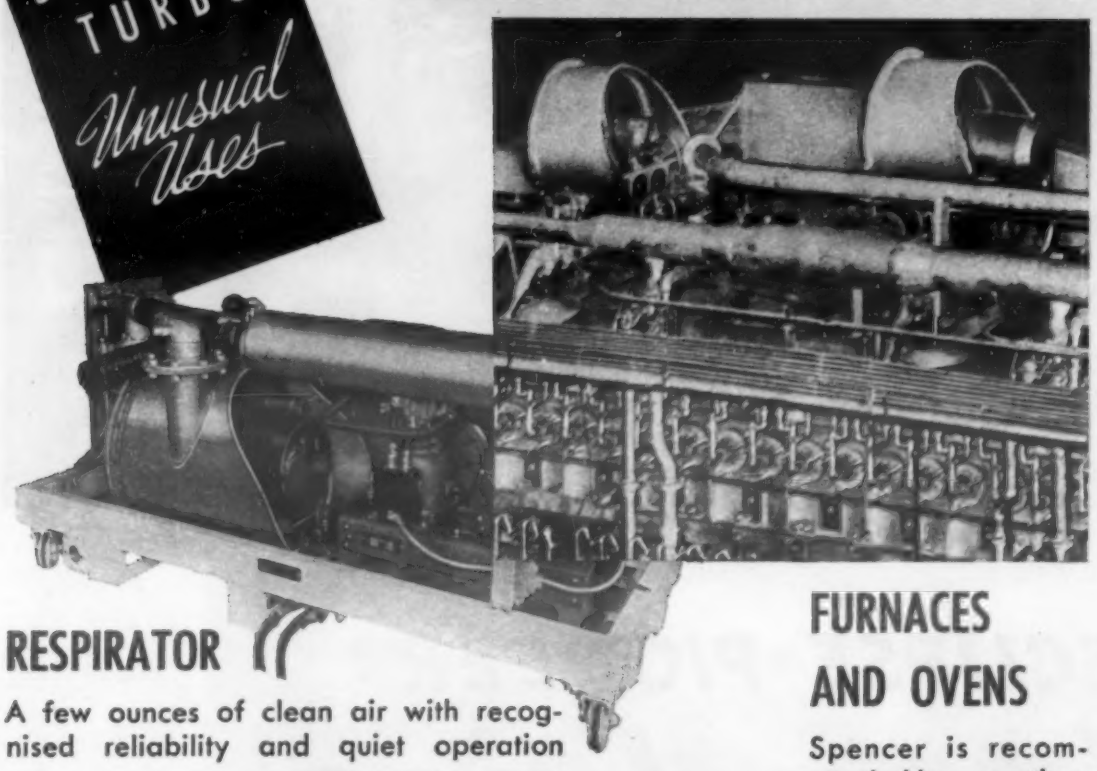
SEWAGE AGITATION

Simplicity of design and wide clearances — ideal for continuous service



SPENCER TURBO *Unusual Uses*

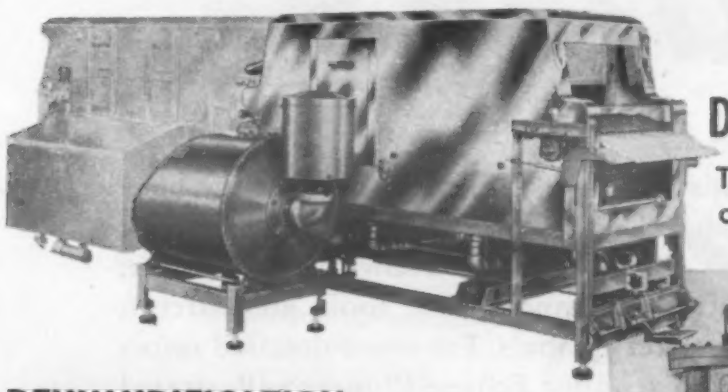


RESPIRATOR

A few ounces of clean air with recognised reliability and quiet operation

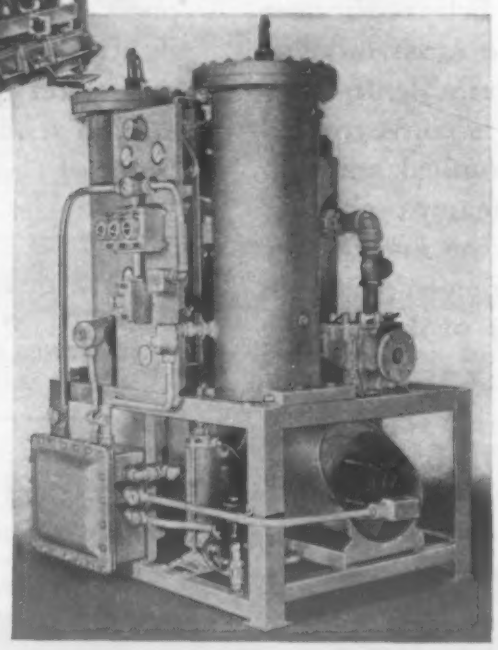
FURNACES AND OVENS

Spencer is recommended by more than thirty manufacturers



DRYING DISHES

The air is filtered—therefore cleaner than that of the room



DEHUMIDIFICATION

The Spencer can be mounted anywhere. There is little vibration

SPENCER VACUUM

Portable and stationary systems in sizes from 1½ to 100 HP are used for metal reclamation, conveying, and more than 100 unusual applications in industry.

ASK FOR SPECIAL APPLICATION DATA

3918

SPENCER HARTFORD

TURBO-COMPRESSORS

THE SPENCER TURBINE CO.
HARTFORD 6, CONN.

New Materials and Equipment

products where corrosion or painting on zinc or cadmium surfaces is a definite problem.

The new compound produces originally an iridescent yellow finish which can be varied in color by changing the concentration of the operating solution and/or incorporating a bleaching step to obtain a clear, bluish, bright-finish. The new finish is also claimed to offer relatively high coverage per gallon, ease of control, and the ability to withstand any harmful effects of a hot rinse.

Light Gage Brass Strip Cleaned in Continuous Cyanide Process

A series of operations involving treatment in a powerful chemical solution, hot water and soap rinses, and uniform drying are carried out in a new cyanide degreasing installation which produces clean, bright, light gage brass strip up to 27 in. in width. Available from *W. S. Rockwell Co.*, this equipment is designed for continuous operation at speeds up to 250 ft. per min.

The entire installation is 67 ft. long and contains six individual sections; four of these sections are directly concerned with the cleaning of the metal. In a preliminary step, the ends of the strip are stitched together to form a single continuous strip.

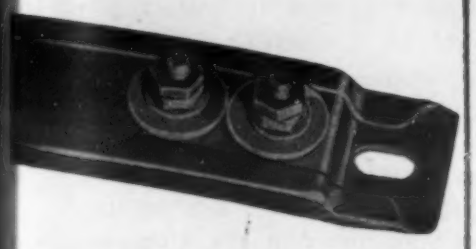
The first of the four stainless steel treatment tanks contains cyanide solution. Constant speed winding reels move the brass strip through the solution while four rotating brushes help remove loosened grease and sediment from the strip surface. Accurate temperature control is achieved by a series of valves incorporated into the steam coil heating system.

The brass strip then passes through a cold water spray unit where all traces of cyanide are removed. From here the strip moves through a hot water washing tank and a soap tank; an adjustable roll allows the strip to bypass the soap solution if desired.

Discoloration of the metallic lustre is prevented by uniform drying under controlled temperature in the last stage of the process. Easy inspection of the quality of the cleaning is made possible by all the spaces between the separate stages of the equipment.

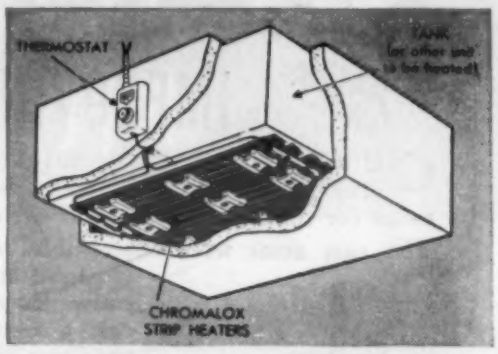
CHROMALOX offers you efficient and economical *Packaged Electric Heat*—to fit your specific needs

CHROMALOX Electric Heaters give dependable "on-the-spot" heat where and when heat is needed. They produce uniform and accurate temperatures with automatic or manual control. *Low* initial cost, *low* installation cost and *low* operating costs are among the other advantages they give you.



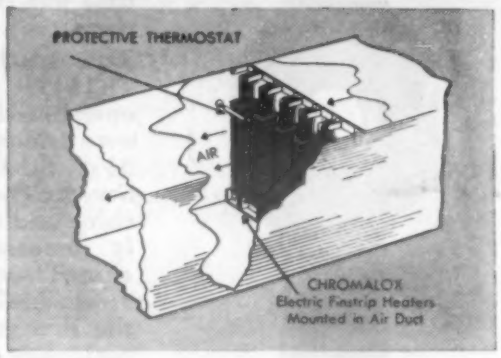
CHROMALOX STRIP HEATERS

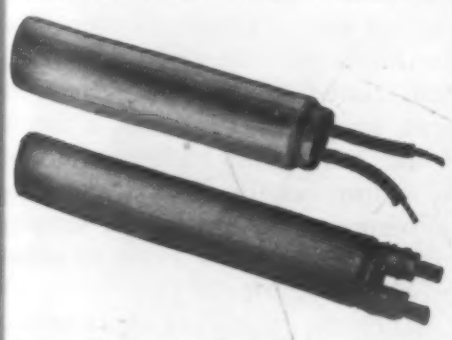
Easy-to-install CHROMALOX Strip Heaters are clamped to flat or curved surfaces, round vats, pipes and tubes. They are made in straight lengths, rings and segments . . . and may be curved or bent to fit cylindrical or "dished" surfaces. Typical applications include: armatures, cleaning tanks, molds, process kettles, plating baths, revolving rolls, etc.



CHROMALOX FINSTRIP HEATERS

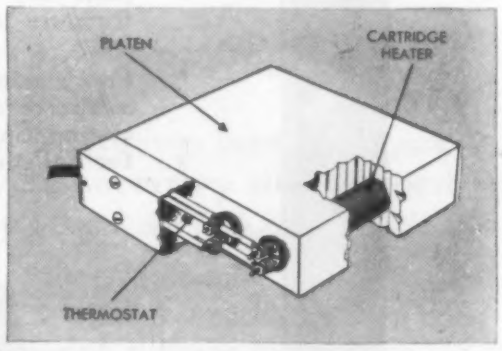
Finstrip Heaters are used for drying, curing, space heating and other applications requiring heated air under forced circulation. Air and gases are quickly and easily heated; uniform operating temperatures up to 750°F. are accurately maintained by thermostatic control. Finstrips, designed for minimum turbulence, are well suited for use in air-ducts.

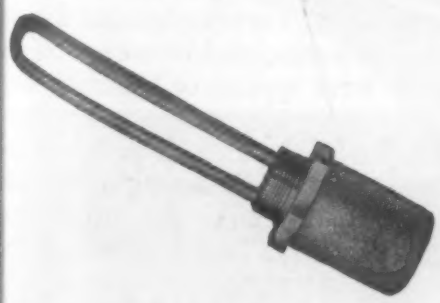




CHROMALOX CARTRIDGE HEATERS

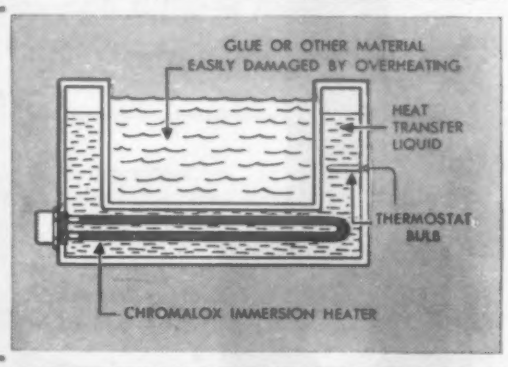
Compact CHROMALOX Cartridge Heaters are ideal for use when concentrated heat is needed. Inserted into close-fitting holes, they provide easily controlled heat for dies, molds, platens, etc. They are quickly and easily installed in stationary or moving parts with minimum labor and material costs; they may be controlled for accurate, dependable, care-free operation.





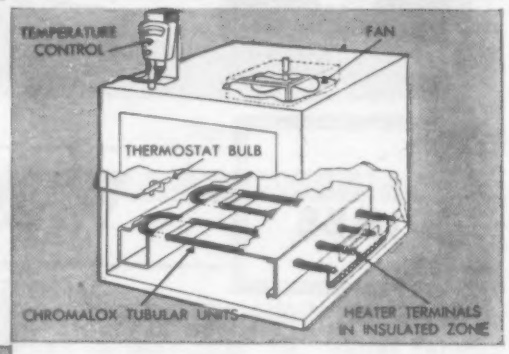
CHROMALOX IMMERSION HEATERS

CHROMALOX Immersion Heaters are used in degreasing, cleaning, pickling and plating baths; for melting greases, asphalts and similar viscous fluids; for heating Dowtherm, Arochlor, Prestone, and other heat-transfer mediums. Available in many sizes and types, with alloy sheaths to resist corrosive action.



CHROMALOX TUBULAR HEATERS

These heaters, in straight or tailored shapes are used for convection, conduction and radiant heating. They may be clamped to metal surfaces, used in ovens, or immersed in greases. They are especially useful to heat ovens, calenders, molding-presses and similar equipment utilizing heat.



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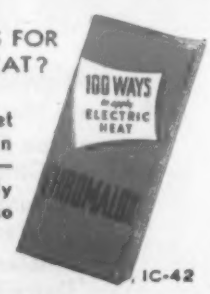

IC-42

"They Switched to SPEED TREAT STEEL PLATE and Cut Machining Time and Tool Costs"

Plus IMPROVING THEIR PRODUCT

CHISHOLM, BOYD & WHITE, Inc., Chicago, builders of brick and clay plant machinery were using cast alloy steel for 10' 9" long side arms for their principal product, quote the "BOYD BRICK PRESS." The cast arms were susceptible to sand holes, were difficult to machine, required more machining because they were necessarily cast oversize and additional time was required to age the parts.

They switched to Speed Treat (X1545) medium carbon, open hearth steel plate. Arms were delivered flame cut from 5½" thick plate, stress relieved. They are easy to machine and tool life was greatly increased. The "as-machined" surface facilitates final machining. With a tensile strength of 90 - 100,000 p.s.i. they excel the castings formerly used for this service.

Free machining Speed Treat is one of the Holliday cost-cutting Speed Steels. Send for Bulletin 901.

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Plants: Hammond and Indianapolis, Indiana

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Horace T. Potts Co., Philadelphia - Baltimore

strength and limit on shape of test specimen and type of loading.

Strength vs Temperature

The relationships between the strength and fracturing characteristics of the low alloy steel, SAE 1340, and its tempering and testing temperatures were discussed in a paper by E. J. Ripling, of Case Institute of Technology, entitled "Tensile Properties of a Heat Treated Low Alloy Steel at Subzero Temperatures."

Specimens of the steel were tempered at various temperatures between room temperature and 1100 F, and groups of these specimens were then tested in static tension at room temperature, —110, —220 and —321 F.

The yield and tensile strengths, which depend primarily on the flow characteristics of the steel, were found to decrease continuously with increasing tempering temperature and with decreasing testing temperature. However, the "fracturing characteristics" (contraction in area and fracture stress) exhibited pronounced minima when obtained on the specimens tested at the lowest temperatures, and determined as a function of the tempering temperature. This minimum occurred at a tempering temperature of 600 F, the temperature near which most steels are known to become brittle.

When the fracturing characteristics were plotted as a function of testing temperature, curves obtained for the specimens tempered between 300 and 700 F were typical of materials having a transition temperature. Tempering temperatures on both sides of this range resulted in an almost linear relationship between testing temperature and the fracturing characteristics.

High Temperature Stability

The stability of more than 100 different types of steel at 900, 1050 and 1200 F is being evaluated over a period of 10 years. Welded samples are included in this investigation. The results obtained in an examination of 16 of these alloy steels, typical of those used in the automotive industry, after 10,000-hr. exposure in air, were presented by A. B. Wilder and J. O. Light, of National Tube Co., in their paper "Stability of AISI Alloy Steels at Elevated Temperatures."

The steels were either normalized or annealed before exposure and, generally, two carbon levels were investigated. The most significant results were as follows:

1. The steels were appreciably

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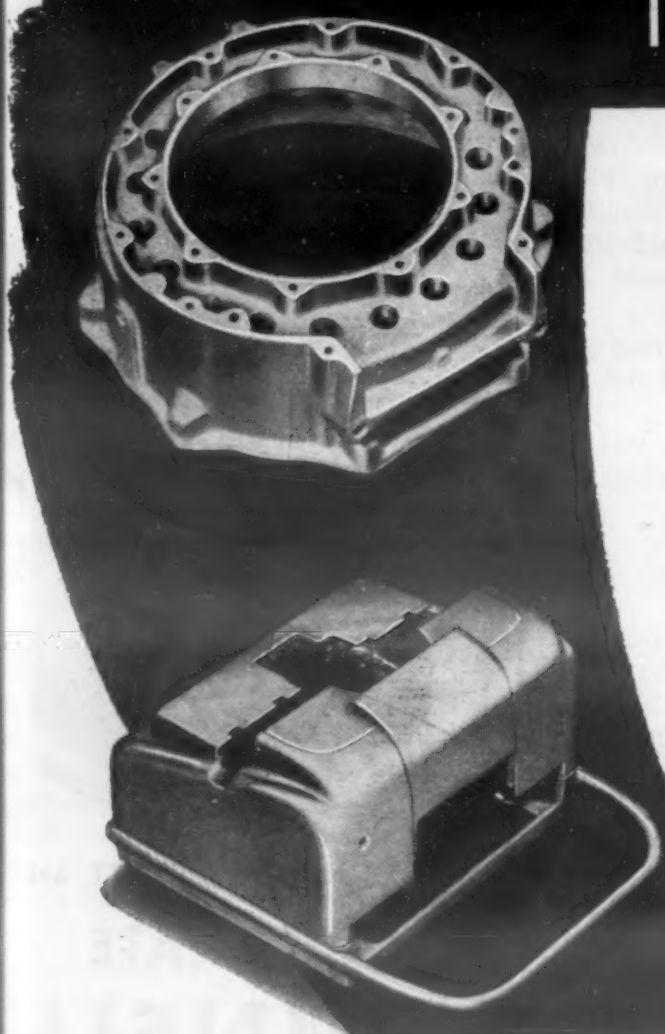
"DOLER-MAG"* MAGNESIUM



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Lightness plus our ability to cast the many holes determined the use of "DOLER-MAG" die casting in this operation.

8½" Diameter x 3⅛" High. Weighs—1.85 lbs.

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UNDERWOOD ELECTRIC TYPEWRITER
(Assembled)

The number of magnesium die castings used in this unit reduce weight and provide necessary stiffness and rigidity. Damping capacity effectively reduces vibration and operational noise.

Six parts—Total Weight 4.573 lbs.
Equivalent steel parts weigh 4 times as much.

*Reg. U.S. Pat. Off.

"DOLER-MAG" *magnesium die castings give you these advantages:*

Lightest weight alloy die cast • Supply inexhaustible Non strategic • Machining at higher speeds • Machining with greater economy • Excellent dimensional stability Excellent noise damping quality • Excellent paint or coat finish • Non sparking • Non toxic • Non magnetic.

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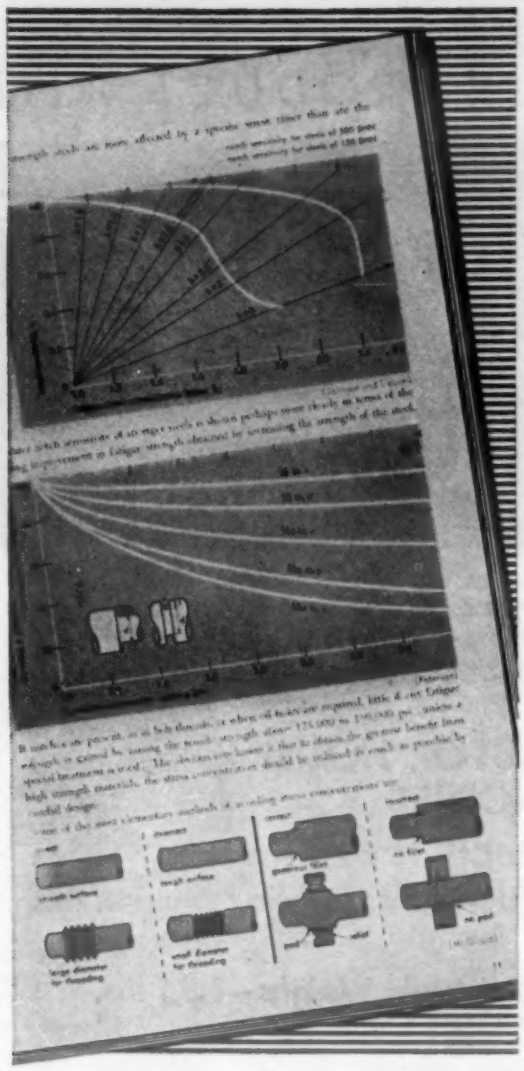

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News Digest (continued)

oxidized and decarburized at 1200 F.

2. The nickel and nickel-molybdenum steels graphitized at 1050 F. Graphite was also observed in AISI 2320 and 4640 steels after exposure at 900 F.

3. The steels containing chromium did not graphitize at either 900 or 1050 F even though an appreciable amount of aluminum was used in the deoxidation practice and, in certain instances, relatively large amounts of carbon were present.

4. The microstructures of the steels containing chromium were more stable than those without chromium. The chromium-vanadium and chromium-molybdenum steels were the most stable.

5. Charpy impact values from ambient temperature tests were not adversely affected.

6. Hardness of the steels was, in general, slightly decreased after exposure.

Boron Additions

The effects of boron additions on steel were discussed in a paper entitled "Effect of Boron and Kind of Boron Addition upon the Properties of Steel," prepared by R. A. Grange and W. B. Seens, of U. S. Steel Corp. Research Laboratory, W. S. Holt, of Jessop Steel Co., and T. M. Garvey, of Carnegie-Illinois Steel Corp. The study covered 13 large commercial heats comprising AISI 1046, 1321 and 4150 grades.

They found that properties were as uniform in heats containing boron as in each corresponding boron-free heat. As expected, hardenability was always considerably increased by the addition of a minute amount of boron. The element appeared to have a grain coarsening effect which was partially overcome by deoxidation with aluminum and by addition of boron in a complex ferro-alloy containing titanium and zirconium.

With the steel fully hardened and tempered, boron had a slight adverse effect upon mechanical properties at low hardness, and possibly a slight favorable effect at high hardness. In the partially hardened and tempered condition, no definite effect was observed, and, in the unhardened condition, the effect upon toughness was adverse.

In AISI 1321, moderately susceptible to temper embrittlement, the addition of boron (particularly as ferroboron) increased that susceptibility. In general, however, the authors found that the properties of

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boron steels were not critically dependent upon the kind of ferro-alloy in which boron was added.

Impact Strength of Speed Steels

Unnotched Izod impact tests were conducted on nine commercially available high-speed steels by Arthur H. Grobe and George A. Roberts, of Vanadium-Alloys Steel Co. The steels included the standard tungsten, tungsten-molybdenum and molybdenum high-speed steel types, as well as two high carbon-high vanadium and three tungsten-cobalt grades. The results of this investigation were presented in a paper entitled "Unnotched Impact Strength of High-Speed Steels."

The highest impact strength was obtained with 6:5:4:2 tungsten-molybdenum steel. Grouped slightly below this level are 1.5:8:4:1 molybdenum steel, 8:4:2 molybdenum vanadium steel, 18:4:1 tungsten steel and 6:5:4:4 tungsten molybdenum-vanadium steel. Grouped in the 20- to 30-ft.-lb. range were the 18:4:1:5 and 18:4:2:8 tungsten cobalt steels and 13:5:5:5 tungsten-vanadium-cobalt steel. Lowest average impact strength was registered for 20:4:2:12 cobalt steel.

The unnotched Izod impact test was found to be relatively insensitive to changes in hardness between Rockwell C-67 and C-57; it is more sensitive to austenitizing temperature and grain size than to hardness.

Chromium-Molybdenum Steels

In "Characteristics and Properties of Cast Low Chromium-Molybdenum Steels," N. A. Ziegler, W. L. Meinhart and J. R. Goldsmith, of Crane Co., presented results of a study of several cast steels recommended for their resistance to graphitization in superheated steam service.

The steels consisted of five groups containing 0.4, 0.7, 1.25, 2.0 and 3.0% chromium with several molybdenum levels between 0.4 and 0.8% and carbon contents between 0.05 and 0.30% within each group. Thermal characteristics, physical properties and weldability were investigated.

The results showed that "thermal sluggishness" or hardenability of these steels is increased by the combined effect of carbon, chromium and molybdenum, but this effect is weak unless carbon exceeds 0.16% or chromium about 2% in this carbon range.

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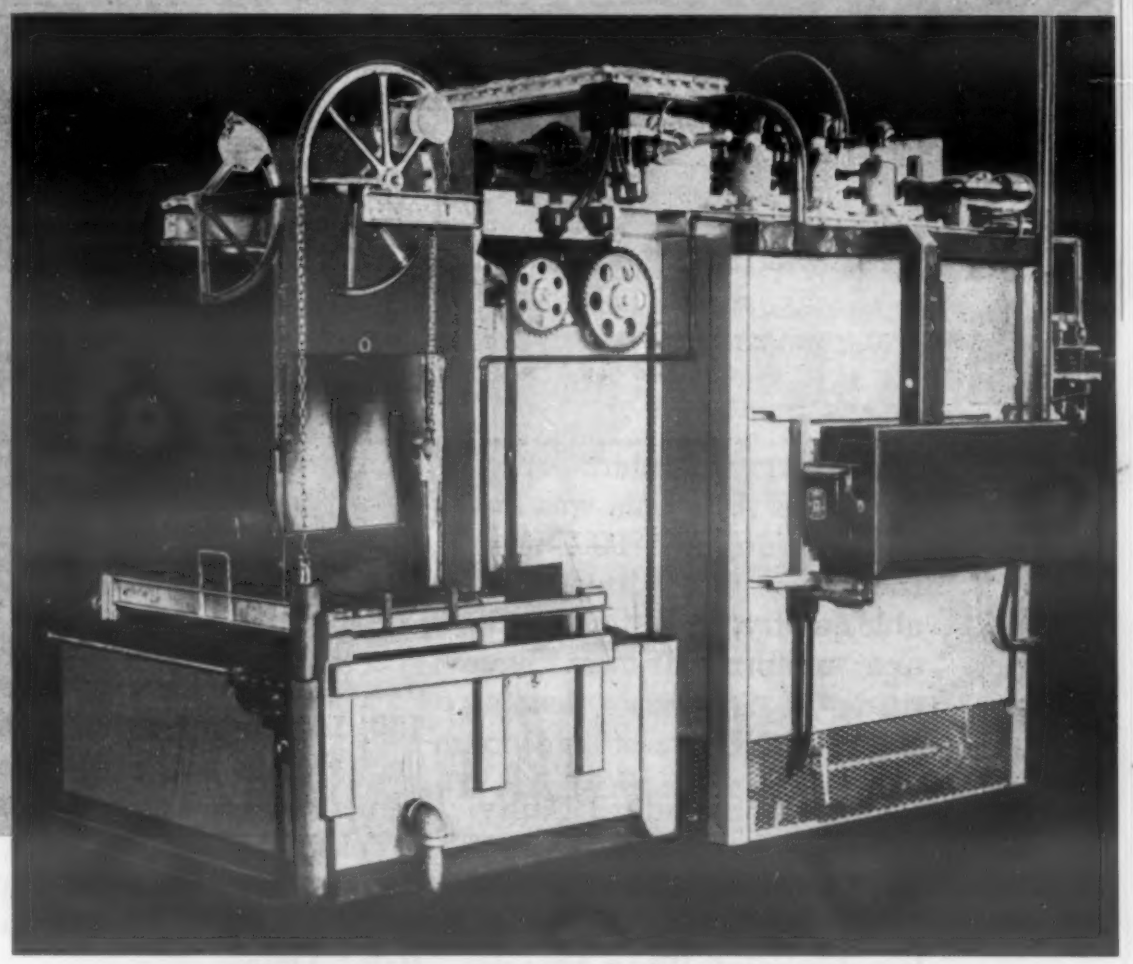

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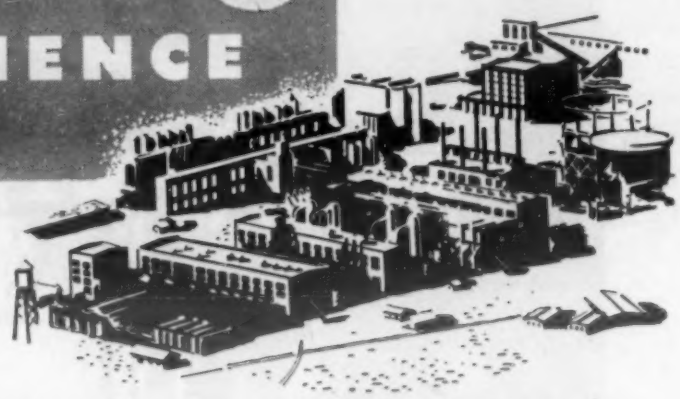

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News Digest (continued)

erally increased tensile strength, yield point and hardness, but decreased elongation, reduction of area and impact resistance in the 0.15 to 0.30% carbon steels. Only slight effect on the low carbon steels was observed. Molybdenum had practically no effect on room temperature properties.

Induction-Hardened Steels

The isothermal transformation diagrams for steels heated by induction can differ markedly from diagrams determined by furnace heating. This conclusion was reached in an investigation conducted by Joseph L. Libsch, Wen-Pin Chuang and William J. Murphy, of Lehigh University, and reported in "The Effect of Alloying Elements on the Transformation Characteristics of Induction-Heated Steels."

The authors believe that for proper selection of alloy steels to be used in induction hardening, the austenitizing cycle and the nature of the alloying elements must be considered. In plain carbon steels and alloy steels containing only ferrite-strengthening elements, the austenitizing cycle is of minor importance, and the properties of the hardened and tempered steel are similar to those obtained with conventional heating.

In alloy steels containing carbide-forming elements, however, the austenitizing cycle assumes primary importance. In order to take advantage of these alloying elements, austenitizing temperatures 150 to 300 F above conventional hardening temperatures are required. These temperatures can be used in induction heating without developing prohibitive grain coarsening, but they will produce somewhat deeper cases in surface hardening.

Quench Cracking

The second of a series of papers on the problem of quench cracking in steel, entitled "An Engineering Analysis of the Problem of Quench Cracking in Steel," was presented by J. W. Spretnak, of Ohio State University, and Cyril Wells, of Carnegie Institute of Technology.

A statistical analysis of thousands of quench cracking data obtained in commercial practice with hollow cylinders revealed that quench cracking in industry occurs in epidemics. These epidemics are quite serious in intensity, relatively short in duration, and are usually separated by long periods of time in which losses due to quench cracks are low and inter-

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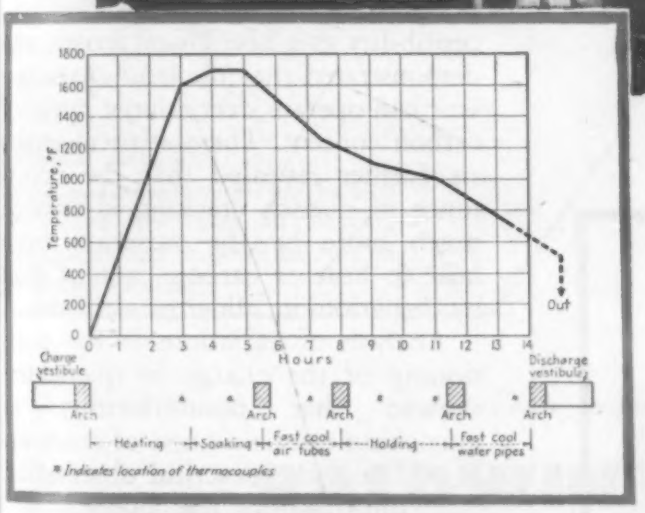

Typical heating and cooling curve used for cycle annealing, showing zoning of furnace and time that the work stays in each zone.

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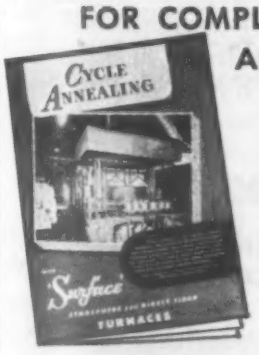

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mittent. Since losses per heat ranged from 0 to 100% in practices where steel chemistry, steel quality and heat treatments appeared to be unusually well-controlled within narrow control limits, it appears that cracking susceptibility is probably a characteristic of the heat.

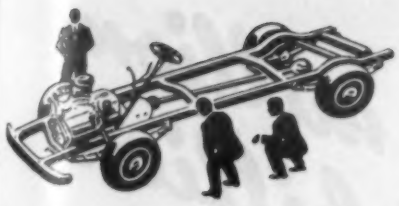
The investigation showed that frequency of cracking decreases with increased pouring temperature of the ingot. There is some evidence to indicate that cracking increases with increasing ingot size and with decreasing forging reduction. The author also found that cracking occurred mainly in cylinders produced from bottom thirds of ingots.

Their results confirmed previous observations that carbon has a marked effect on susceptibility to cracking. The probability of cracking at least one cylinder per heat increased with increasing carbon content, but the severity of cracking (proportion of the heat cracked) was independent of carbon content. This behavior supported the concept of cracking susceptibility as a heat characteristic and demonstrated that the heat characteristic can operate over a large range of carbon content. The statistical analysis further revealed that the occurrence of quench cracking is affected much more by the variation from heat to heat of carbon content than by variation in alloying elements.

Analysis of variations in the positioning of the charge in quenching showed that nonuniformity in quenching can be a cause of cracking. In addition, the practical observation that interrupting the quench will decrease cracking was confirmed by a negative correlation between frequency of cracking and the temperature to which the cylinder was quenched. Among the remedies tried for the purpose of preventing quench cracks, that of pre-bore quenching appears to be one of the most effective.

Temper Brittleness

The problem of temper brittleness in steels is receiving considerable attention from metallurgists today. One recent report on this problem is "Influence of Composition on Temper Brittleness in Alloy Steels," by A. P. Taber and J. F. Thorlin, of the Ordnance Department, and J. F. Wallace, of Watertown Arsenal Laboratory. Holding as constant as possible the significant variables, the authors determined the influence of various amounts of chromium, manganese,



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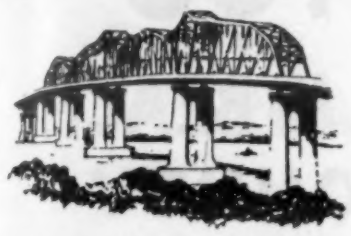

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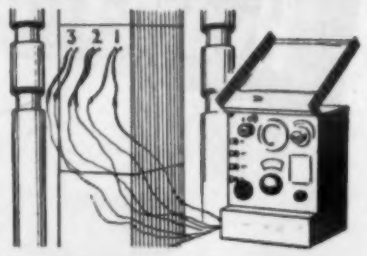

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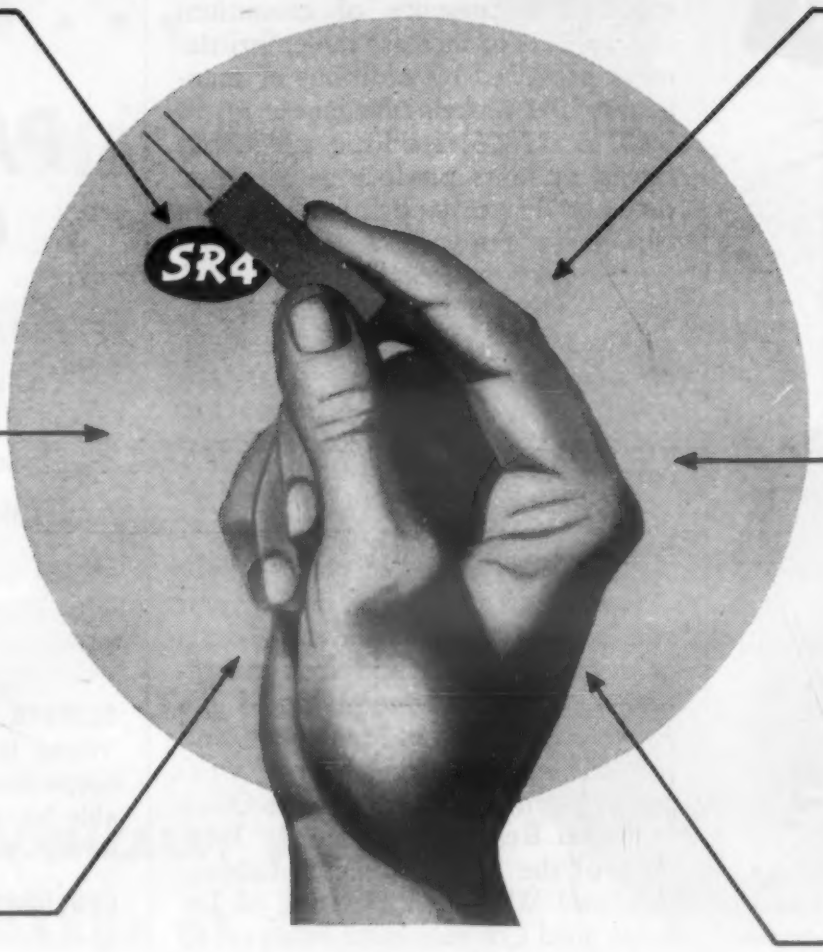

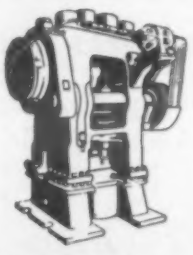

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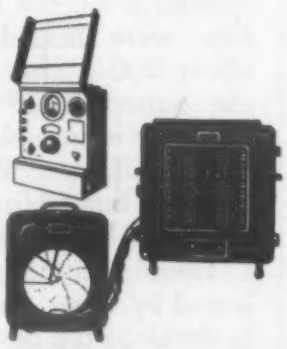

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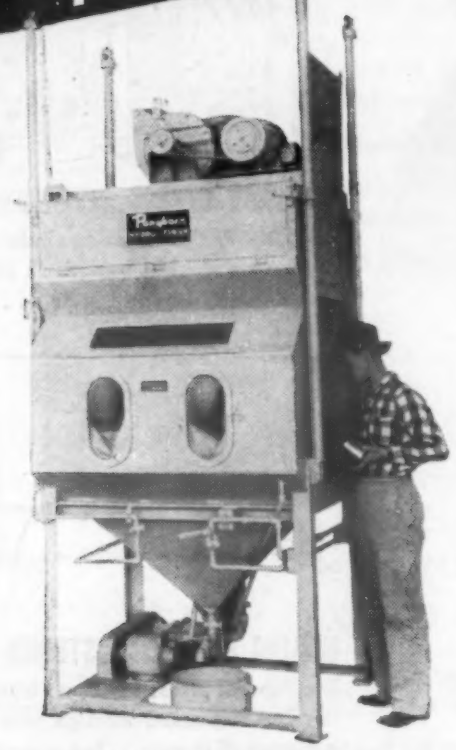

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News Digest (continued)

nickel and molybdenum on temper brittleness in low and medium alloy steels.

The samples were furnace-cooled from the tempering temperature at the rate of 32.4 F per hr. The results indicate that chromium causes considerable increase in the susceptibility of alloy steels to temper embrittlement. The presence of chromium also appears to increase the embrittlement produced by additions of manganese and nickel. Manganese up to 0.60 to 0.70% has little effect, but larger amounts produce as much or possibly more embrittlement than chromium. From four to five times more nickel than chromium or manganese (above 0.60 to 0.70%) is required to produce the same embrittling effect. Molybdenum, at least up to 0.25%, greatly decreases susceptibility of these steels to temper embrittlement.

Iron-Manganese Alloys

Results of a study of the thermal and mechanical behavior of a series of iron-manganese and iron-manganese-nickel alloys were presented in a paper entitled "Iron-Manganese and Iron-Manganese-Nickel Alloys," written by Irvin R. Kramer, of the Office of Naval Research, Stewart L. Toleman, of the Naval Research Laboratory, and Walter T. Haswell, of Latrobe Steel Co. The study was part of an effort to develop alloys which, when slowly cooled from the austenitizing temperature, have strength and ductility properties equivalent to those of quenched and tempered steel.

It was found that austenite was formed when the iron-manganese alloys were heated to temperatures above 800 F after first cooling from the austenitizing temperature. This austenite is unstable at room temperature and decomposes, causing embrittlement, but additions of nickel stabilize the austenite.

Double tempering at 1110 F, followed by water quenching, apparently develops the best mechanical properties of these iron-manganese-nickel alloys. Alloys containing 3.4 to 3.7% manganese, 1.4 to 1.5% nickel, 0.4 to 0.5% molybdenum (without chromium) or 3.0 to 3.3% manganese, 2.2 to 2.3% nickel, 0.4 to 0.6% molybdenum, 0.1 to 0.2% carbon, 0.4% silicon (max.) have a tensile strength range of 100,000 to 140,000 psi. with good ductility. A tensile strength range of 140,000 to 200,000 psi. can be obtained by addition of 0.15 to 0.20% vanadium.

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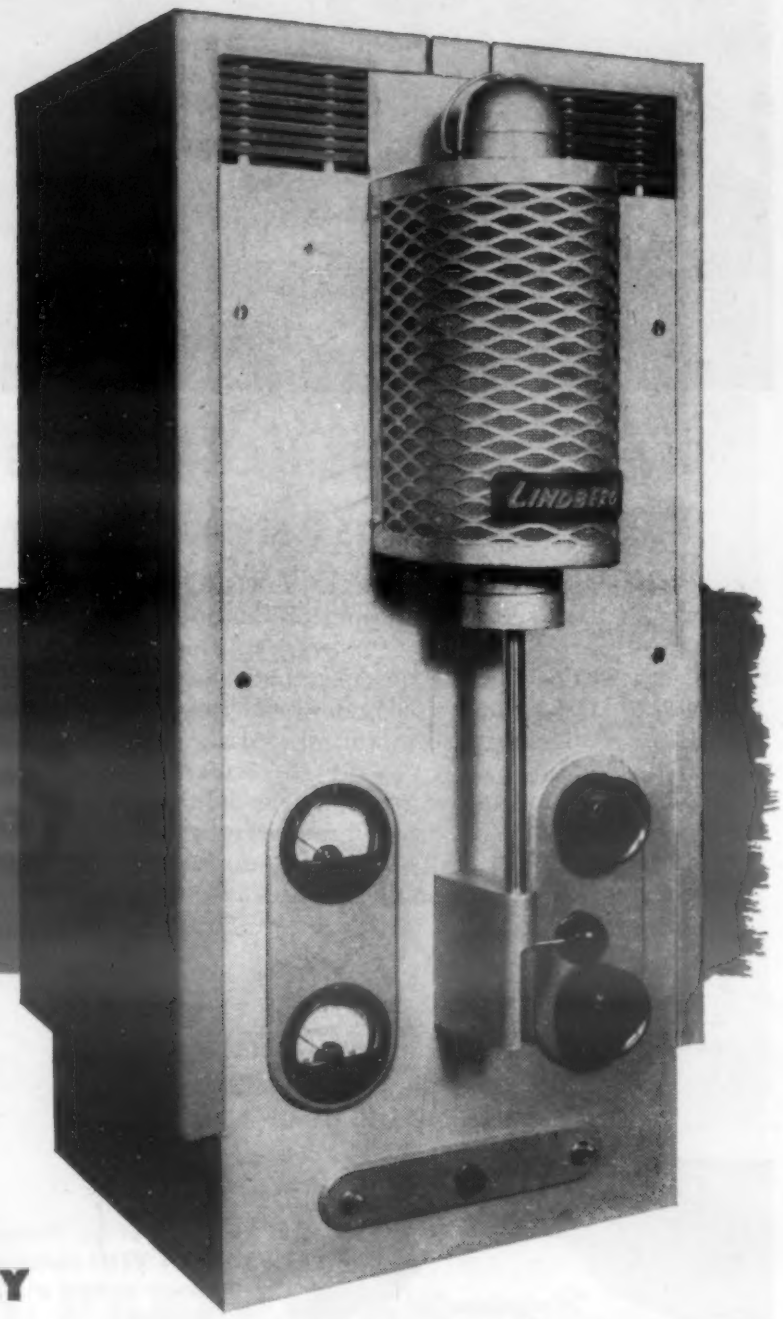

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● The gas-fired roller hearth furnace pictured above is of EF's semi-continuous intermittent operating design, with separate chambers for preheat, anneal and cool. Special ratio controls produce the exact atmosphere desired, and an ingeniously designed forced circulation system assures a uniform anneal and surface finish day after day. Let us show you how EF research, EF design, and EF experience has greatly advanced the metallurgical processing of ferrous and non-ferrous metals, resulting in closer physical tolerances, uniform finish, and efficient, low cost, trouble-free operation

THE ELECTRIC FURNACE CO.
GAS FIRED, OIL FIRED AND ELECTRIC FURNACES
Salem - Ohio

Here's the "Winning Eleven" team of the RUST VETO series—now being presented to industry to meet practically every metal corrosion problem.

Each Houghton field man has this kit of samples to show you. It includes five solvent types, three inhibited oil and two grease types, and a concentrate for dilution in your plant. The twelfth jar contains a straight solvent for removal of the preventive after you observe its film on steel.

The chart on this kit gives all physicals and complete description. This data will also be found in a new folder, sent upon request mailed to E. F. Houghton & Co., 303 West Lehigh Avenue, Phila. 33, Pa.

RUST VETO

Ask the Houghton Man to show you this sample kit, to help you select the preventive best fitting your own need.

News of...

ENGINEERS
COMPANIES
SOCIETIES

Engineers

David M. Rush has been appointed materials engineer of the Manufacturing Div. of the General Electric Co.'s Air Conditioning Dept. Mr. Rush had been engaged in special assignment work, serving as a member of the staff of the manager of manufacturing for G.E.

The American Gas Furnace Co. has announced that *Adolph W. Machlet,* president and treasurer, has been elevated to chairman of the board of directors. *Philip C. Osterman,* associated with American Gas Furnace for more than 45 years in the management of the business, succeeds Mr. Machlet as president and treasurer.

N. L. Watkins has joined the Almco Div. of Queen Stove Works, Inc., as chief development engineer. Mr. Watkins previously served as manufacturing engineer for Westinghouse Electric Corp.

Following his resignation as director of engineering for the Atomic Energy Commission, *Roger S. Warner* joined the staff of Arthur D. Little, Inc.

The appointment of *H. R. Salisbury* as president of Air Reduction Sales Co. has been announced. He has been with Air Reduction over 23 years in various executive capacities. Several vice presidents were also named, including *H. F. Henriques,* general sales; *J. J. Lincoln, Jr.,* railroad sales and sales services; *S. B. Stouffer,* distribution; and *N. L. Wisser,* field office management.

E. J. de Ridder, prominent European engineer, recently became a member of Reynolds Metals Co.'s staff of technical service engineers. Mr. de Ridder, who has been assigned to aluminum design work, will make his headquarters at the company's General Sales Div. offices in Louisville, Ky.

Lukens Steel Co. has named *Robert W. Wolcott,* president of Lukens since 1925, chairman of the board. *Charles Lukens Huston, Jr.,* vice president and executive assistant to the president, succeeds Mr. Wolcott as president of the company.

James W. Kirkpatrick has joined the Youngstown Sheet & Tube Co. as chief metallurgist in the Youngstown district. Prior to this position, Mr. Kirkpatrick was assistant metallurgical engineer for the H. A. Brassert Co.

The appointment of *Milo Franklin McCammon* as general manager of the

POLYTHENE-LINED PAPER BAG PROTECTS MOISTURE-SENSITIVE GLUE

Multiwall bag with a polythene-coated ply has improved resistance to atmospheric moisture over a wide range of temperatures...plus many other advantages

When The Borden Company needed an economical, damp-proof package for a very hygroscopic powdered resin glue, they chose a sturdy, lightweight, inexpensive multiwall paper bag, one layer of which has a thin coating of Du Pont polythene plastic. These bags keep moisture out during handling and shipping, protect contents until used. Compared with many other types of containers, the empty bags save up to 91% of storage space—save shipping costs, too.

The use of paper coated with Du Pont polythene in multiwall bags provides these advantages:

- **better protection against moisture**
- **better chemical resistance**
- **better strength**
- **better grease resistance**

These characteristics are retained over a wide range of temperatures. The use of a polythene-coated ply also offers greater versatility, since film thickness can be varied to meet specific requirements.

Many other "hard-to-pack" products are being successfully shipped in these bags, including calcium chloride, dry milk, meat trimmings, sodium bisulfite, benzene hexachloride, quicklime, various synthetic resins.

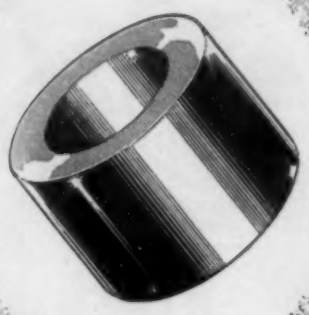
The multiwall bag is only one of many new packaging applications of polythene. The new coating technique used here is a joint development of St. Regis and Du Pont technical men. Du Pont representatives will gladly work with extruders, molders, or converters, or will suggest suppliers who can meet specific needs for packaging or other uses of plastics. Write today for free literature on polythene and other versatile Du Pont plastics.

(Multiwall bag made by St. Regis Paper Co., New York, New York.)

E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Main Sales Offices: 350 Fifth Ave., New York 1, New York; 7 S. Dearborn St., Chicago 3, Illinois; 845 E. 60th St., Los Angeles 1, California.

DU PONT
REG. U.S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

WORKS WHERE OTHERS WON'T



accurately formed

GRAPHALLOY OILLESS BEARINGS

SPECIFY GRAPHALLOY TRADE MARK REG. U. S. PAT. OFF. WITH CONFIDENCE

SELF-LUBRICATING ● EXTREMELY DURABLE ● CONSTANT CO-EFFICIENT OF FRICTION ● OPERATES DRY — OR *SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS* ● APPLICABLE OVER A WIDE TEMPERATURE RANGE — *even where oil solidifies or carbonizes* ● EXCELLENT AS A CURRENT-CARRYING BEARING.

GRAPHITE METALLIZING CORPORATION

1010 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

News of...

ENGINEERS COMPANIES SOCIETIES

Stamford Div. of the Yale & Towne Manufacturing Co. has been announced. Mr. McCammon resigned as general manager of the Ingersoll Steel Div. of Borg-Warner Corp. to accept this post.

Waldemar Naujoks, well-known authority on drop forging techniques, has joined the Ladish Co. in the capacity of special projects engineer, where he will concentrate on the development of ferrous and nonferrous alloy forgings.

National Research Corp. announces the additions of *Arthur E. Franks* and *Gordon E. Findlay* to its Metals Research Dept. staff. Mr. Franks will be engaged in the development of new products and of high vacuum furnaces for metallurgical processing, while Mr. Findlay will do research in the field of applied physics.

Melville Morris recently was appointed president of the Optimus Equipment Co. He previously had been executive vice president of the company, a subsidiary of Hanson-Van Winkle-Munning Co.

Two vice presidents have been named by the National Carbide Corp. They are *Robert A. Speck,* in charge of sales and distribution; and *George R. Milne,* in charge of operations. Mr. Milne will continue to make his headquarters in Louisville, Ky.

The retirement of *Leland T. Weller,* after more than 25 years of service, has been announced by the General Electric Co. Mr. Weller was carboloy specialist for G.E.'s Apparatus Dept.

Eugene M. Smith has joined the Youngstown Sheet & Tube Co. as flat rolled products development engineer. Mr. Smith, formerly research engineer at Battelle Memorial Institute, will be located at the company's Campbell plant.

Officers named for the newly-created Affiliated Furnace & Engineering, Inc., an associate of Chemsteel Construction Co. Inc., include the following: president and general manager—*Arthur M. Krieger,* formerly manager of the Estate Heatrola Div. of Noma Electric Corp.; vice president, engineering—*Clarence B. Avery,* vice president, engineering for Chemsteel; vice president, construction—*Merrill A. Stewart,* secretary-treasurer of Chemsteel; and secretary-treasurer—*Charles E. Stone,* president of Chemsteel.

Roy C. Menzel has been promoted from works manager to the position of secretary-treasurer of General Motors Corp. His headquarters will be at the Oakland, Calif. plant.

The new position of manager of foundry operations in the Pittsburgh district for the Blaw-Knox Co. has been assumed by *N. B. Ornitz,* vice president of the company. This added responsibility will be in addi-

Solve Your Sintering Problems

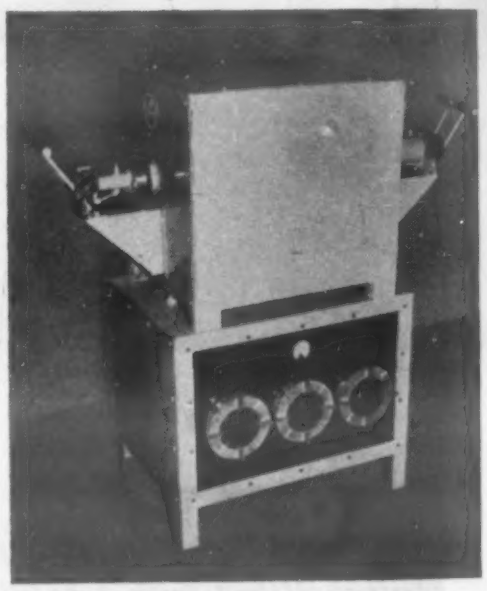
WITH

Harper

Electric

SINTERING FURNACES

TEMPERATURES TO 4500°F.



GT-20-HM-30 Tube Furnace ideally suited for testing small parts.

RESEARCH AND PRODUCTION UNITS

WHETHER your problem lies in research or production you will want to investigate the complete line of Harper Electric Sintering Furnaces.

WRITE FOR Bulletin 1148 for information on research units, as pictured above, which will enable you to determine the maximum temperature, rate of heating and cooling, time at temperature and proper atmosphere for your product.

WRITE FOR Bulletin 847 on standard pilot and production models.

CONSULT Harper Engineers on special sintering furnaces to meet your special requirements.

HARPER ELECTRIC FURNACE CORPORATION

1461 Buffalo Ave., Niagara Falls, N. Y.

Representatives in Principal Cities

Koppers Co. Inc.

heat forms their famous "American Hammered" Piston Rings

Baltimore, Maryland

Illustration above shows rings entering furnace, prepared on fixtures.

ELECTRIC CERTAIN CURTAIN FURNACES

in "Certain Curtain" LAC Furnaces

Accurate automatic control of conveyor drive and temperatures through three zones of electric heat. These "Certain Curtain" furnaces, now permit the piston ring to be heat formed after careful preparation on fixtures, replacing the old hammer method. This method improves the properties, and also assures exact duplication of these desired properties day in and day out. Protective atmosphere keeps the work clean throughout the heating and cooling cycle of 100,000 rings per day production for each of the Hayes furnaces set up in Koppers' production lines.

Illustration below shows unloading of fixtures with rings heat formed and possessing desired physicals to meet exact requirements.

C. I. HAYES INC.

80 BAKER ST., PROVIDENCE, R. I.

R. G. REES
Room 711, 30 Journal Sq.
Jersey City, New Jersey

E. F. BURKE AGENCY
Room 600, 1900 Euclid Ave.
Cleveland 15, Ohio

JOHN C. FISHER CO.
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Pittsburgh 19, Pa.

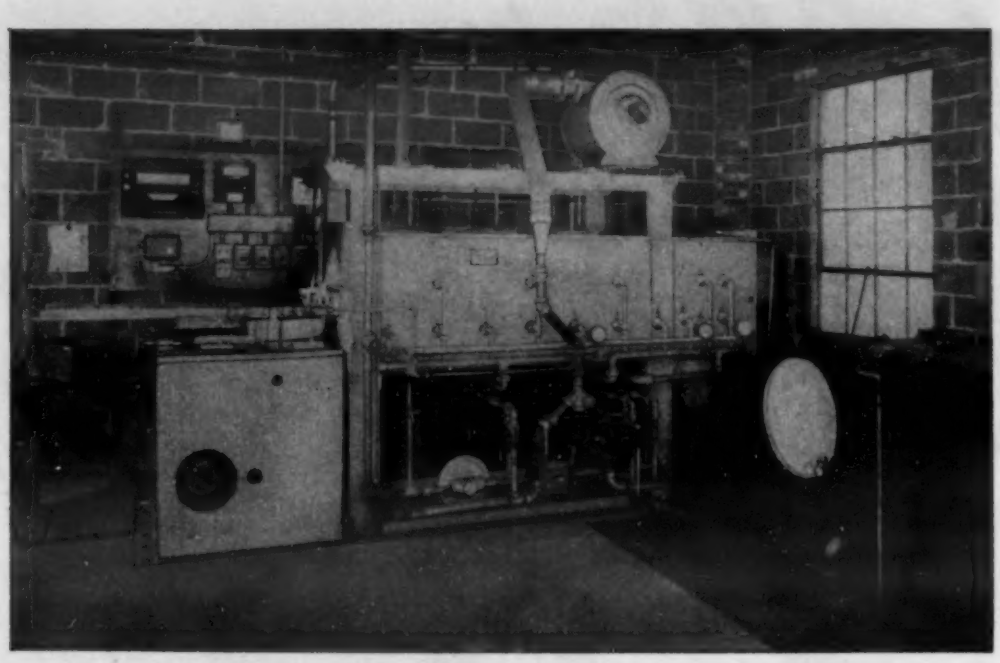
C. A. HOOKER
302 Forest Ave.
Royal Oak, Mich.

DOLAN IND. SALES
Union National Bank Bldg.
Houston, Tex.

L. WAGNER
312 Laumer Avenue
San Jose 12, Calif.

W. G. PRAED
416 N. State St.
Chicago, Ill.

L. J. EDWARDS
New England Rep.
75 Baker St., Prov., R. I.



RECIPROCATING, CONTROLLED ATMOSPHERE FURNACES

SUITED TO WIDE RANGE OF GENERAL AND ATMOSPHERE WORK

VERSATILE. A.G.F. Reciprocating Furnaces are suited to continuous clean hardening, annealing, normalizing, case-hardening by the patented Ni-Carb process, etc. Work treated in the same furnace may range from extremely small light springs, stampings, drop forgings, etc. up to quite large and heavy pieces.

THE RECIPROCATING MUFFLE advances work through the heat by its own momentum. Heat losses and maintenance problems are reduced to a minimum by the complete elimination of conveying mechanism from the heating chamber. There is no traveling belt to be alternately heated and cooled—only work enters and leaves the furnace.

Write for Bulletin 815-AB today.

AMERICAN GAS FURNACE CO.

142 SPRING STREET · ELIZABETH, N. J.

WESTINGHOUSE

handles sheets the Easy Way

Here's a 10 ton C-F Lifter handling bundles of sheet steel in a Westinghouse plant with ease and safety. High grade sheets like these, used in stator and rotor laminations, must be handled carefully—and in a busy plant, they must be handled quickly. That's why a C-F Sheet Lifter is doing the job.

C-F Lifters are made in manual or motor models in capacities from 2 to 60 tons or larger, in standard or semi-special designs. Write for the illustrated bulletin "C-F Lifters"—it may help solve a tough materials handling problem for you.

CULLEN-FRIESTEDT CO.
1314 S. Kilbourn Ave., Chicago 23, Ill.

HANDLE SHEETS with C-F LIFTERS

News of...

ENGINEERS COMPANIES SOCIETIES

tion to Mr. Ornitz's other duties.

John A. Stierstorfer has been appointed senior synthetic enamel chemist at the Stamford, Conn., branch of the Atlas Powder Co.'s Industrial Finishes Dept.

The election of *Bruce A. Fleming* to the board of directors of the Edwin L. Wiegand Co. has been announced. Mr. Fleming is vice president in charge of sales of the company.

Merton A. Robinson, dean of American ballistics, has retired after 45 years of service with the Winchester Repeating Arms Co., a division of Olin Industries, Inc.

Superior Steel Corp. has elected *William M. Cowles,* general sales manager, to the position of sales vice president of the company.

Winston I. Parks has been appointed research and public relations director of Adams Steele, Inc. He previously served as research director of Benge Associates.

Douglas B. Hobbs died in New York City while attending a convention of the Association of National Advertisers. Mr. Hobbs was in charge of motion pictures educational and technical information activities of the public relations and advertising department of Aluminum Co. of America.

Companies

The United Engineering & Foundry Co., Pittsburgh, Pa., has purchased the *Stedman Foundry & Machine Works,* Aurora, Ill. The firm name will be retained and operations continued as in the past. New officers of Stedman include the following: chairman of the board, K. C. Gardner; president, G. G. Beard; vice president and general manager, A. E. Schneider; treasurer, G. V. Lang; and secretary and assistant treasurer, Lester Etter.

The corporate name of *Kaiser Engineers, Inc.,* Oakland 4, Calif., has been changed to *Kaiser Industries, Inc.* The engineering and construction division will continue to do business as *Kaiser Engineers, Div. of Kaiser Industries, Inc.* The name change in no way affects the operations, functions or personnel of the company.

Construction of a new 5-story building has been started by the *Edwin L. Wiegand Co.* at its Thomas Blvd. location in Pittsburgh, Pa.

The *Barnes Manufacturing Co.,* Mans-

These partners are NOT SILENT!

One partner is Tension, one Compression, one Bend, one Flexure and all work as a team in an Olsen Universal Testing Machine. As a team they predetermine the physical properties of metals—for safety, for economy, for endurance and, fortunately, for development. There never could have been a skyscraper, or an automobile, or an airplane, or a thousand and one other everyday things, without these master machines—these seers that accurately foretell the future. The definitive signals of these machines can never be misconstrued. Through the years the Olsen Universals have given dependable service to the men in the laboratories, those men who dreamed and made, through unending perseverance, those dreams come true. Some might call the Olsen Universals partners of progress.

Write today for Bulletin 30

TINIUS OLSEN

Testing & Balancing Machines

TINIUS OLSEN
TESTING MACHINE CO.
2010 Easton Rd., Willow Grove, Pa.

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

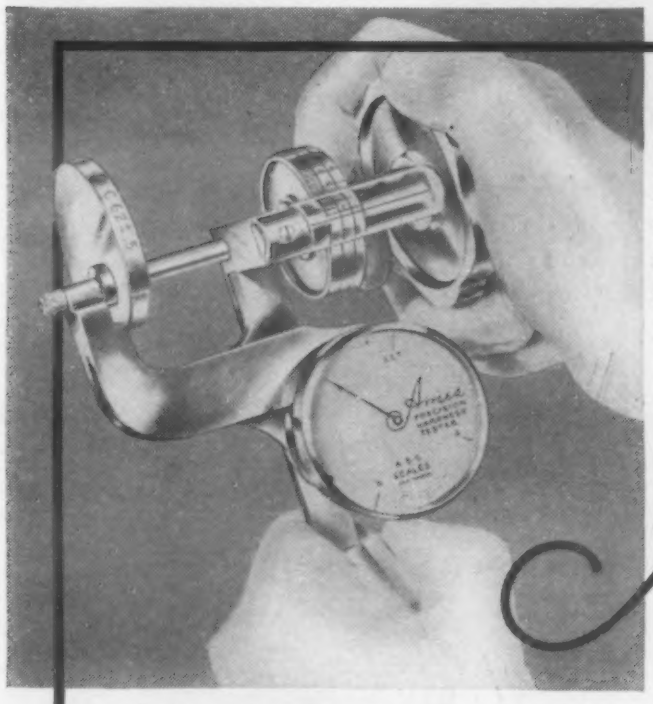
The accepted melting tool in brass rolling mills throughout the world.

* *Upwards of 5 billion pounds annually.*

AJAX ELECTRIC FURNACE CORP.
1108 Frankford Avenue • Philadelphia 25, Pa.

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*



For accurate, on-the-spot hardness tests on production line, in stock room, warehouse or in the shop. Used by inspectors, field men, engineers, salesmen.

Ames PORTABLE HARDNESS TESTERS

Amazing savings in time and expense can be realized by taking the Ames Hardness Tester to the work. For hardness testing flat or round stock, tubing, duplicate parts, knives, saws and irregular shaped pieces, reading directly in the Rockwell Scales. No cutting off specimens. No laboratory delays. Complete with wooden carrying case. Several sizes. Write for bulletin.

AMES PRECISION MACHINE WORKS
Makers of Precision Bench Lathes & Milling Machines
WALTHAM 54, MASSACHUSETTS

News of...

ENGINEERS COMPANIES SOCIETIES

field, Ohio, and the *Non-Ferrous Die Casting Co., Ltd.*, London, England, have formed a new company—*Non-Ferrous Perma Mold, Inc.*—with factories in Mansfield. This new company is scheduled to bring to the United States many new techniques in the art of permanent mold casting.

Production facilities at the Dobbs Ferry, N. Y., plant of *North American Philips Co., Inc.* are being curtailed, and the plant will be closed when necessary arrangements have been completed. Part of the equipment at Dobbs Ferry is being moved to other Philips plants, which will permit the manufacture of a number of items to continue, including Ferroxcube. The Application and Engineering Departments will be moved to the Mt. Vernon, N. Y. plant.

Allied Research Products, Inc., Baltimore, Md., has purchased the building at 4004 E. Monument St., which has housed the company for the past three years. Extensive renovations are being planned.

Lou Mervis, Pittsburgh industrialist, has acquired controlling interest of the *Ottumwa Iron Works*, Ottumwa, Iowa. Mr. Mervis becomes president of the concern, and other officers include E. R. Phillips, vice president in charge of sales; Francis Knuth, vice president; John Thurlow, secretary; and Myra Mervis, treasurer.

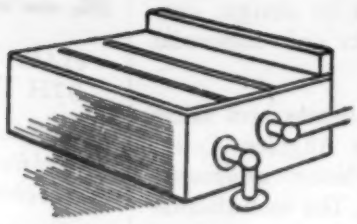
The plant, land, buildings and equipment comprising the machine shops of *Lobdell Co.*, Wilmington, Del., have been acquired by the *United Engineering & Foundry Co.*, Pittsburgh, Pa. This eighth subsidiary of United will be named *Lobdell United Co.*, and officers of the new company consist of the following: chairman of the board—K. C. Gardner, president of United; president—G. G. Beard, executive vice president of United; vice presidents—W. Hagel, vice president, in charge of sales of United, and H. A. Laws, former vice president of Lobdell Co.; treasurer—G. V. Lang, treasurer of United; and assistant secretary and assistant treasurer—Frank Fitzgerald, treasury staff assistant of United. No further changes in the personnel or the operations of the plant are contemplated.

Motors & Metals, Inc., New York 17, N. Y., have announced that they are in full production for immediate delivery to local distributors in all cities of the complete range of sizes of standard shapes and forms of Meehanite castings.

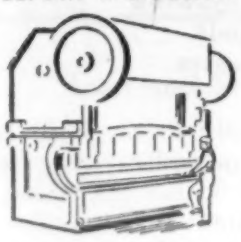
Creation of a new associated company—*Affiliated Furnace & Engineering, Inc.*—has been announced by *Chemsteel Construction Co., Inc.*, Pittsburgh, Pa. The new

Simplify production with economical vapor degreasing

BEFORE INSPECTION



BEFORE PLATING



AFTER STAMPING

AFTER MACHINING

BEFORE AND AFTER production steps, Vapor Degreasing can save you time and cost. In one operation, in one minute or less, it thoroughly removes grease and oil from parts made of most materials—of any size or shape. And it reaches almost inaccessible places . . . leaves parts clean, warm and dry.

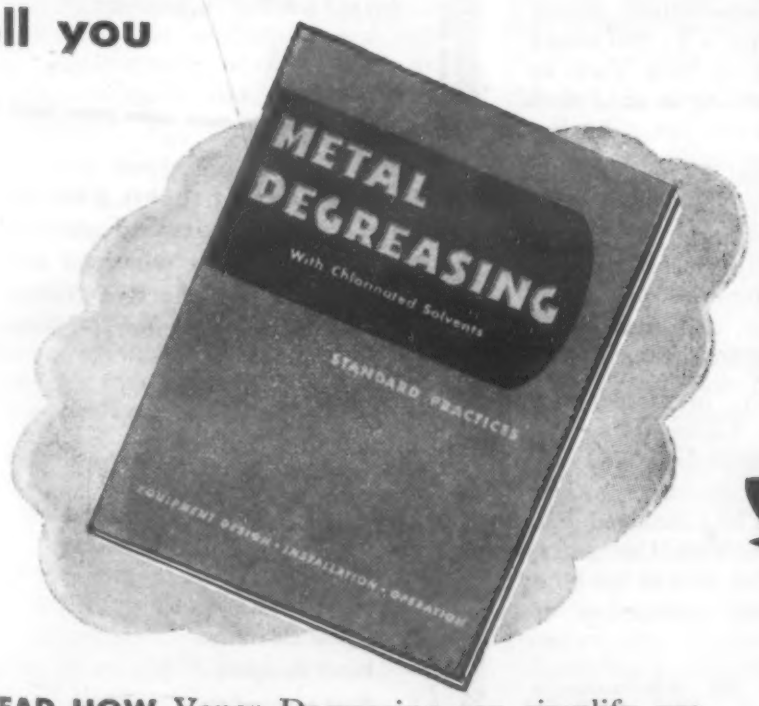
Get outstanding results with new, improved "Triclene" D Trichlorethylene

"TRICLENE" D is the most stable grade of Trichlorethylene yet developed by Du Pont for metal degreasing. It stands up against contaminating and destructive materials which may be introduced in degreasing . . . assists materially in carrying out efficient cleaning.

INTRODUCING "PERCLENE" D

A new degreasing grade of Perchlorethylene for use in metal drying and other vapor degreasing operations in which a higher boiling solvent may be desirable.

Let this book tell you



READ HOW Vapor Degreasing can simplify production . . . save you time and unnecessary costs. Read why the results obtained can't be matched by any other method. It shows typical compact equipment available for efficient and economical operation. And it gives information about solvents used in this equipment—Du Pont "Triclene" D Trichlorethylene, and Du Pont Trichlorethylene and Perchlorethylene—which under various trade marks have been widely used for many years. Send for it today!

DU PONT non-flammable SOLVENTS for VAPOR DEGREASING

SOLD NATIONALLY THROUGH DISTRIBUTORS

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

CLIP THIS COUPON—MAIL TODAY!

E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Dept., Wilmington 98, Delaware

Please send me my copy of "Metal Degreasing—Standard Practices."

Name_____

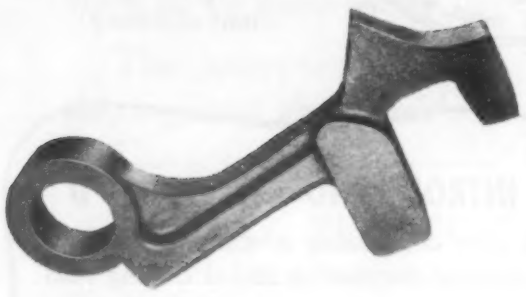
Position_____

Firm_____

Address_____

Designers Take Notice!

Why don't you take advantage of the opportunities offered by precision investment castings?



You, too, can get parts of complicated shapes similar to the piece illustrated in any alloy, ferrous or non-ferrous.

Part shown weighs ¼ pound, is .375" thick and 4" long. Made of corrosion resistant type #440-C Stainless Steel.

Piece is complete ready for use except for reaming hole, grinding pads to very close tolerance and milling fine serrations on tip.

We would be glad to help you reduce costs on your expensive parts.

Please use the coupon.

GRAY-SYRACUSE Inc. . . . . .

107 N. Franklin St., Syracuse 4, N. Y.

Small precision castings of ferrous and non-ferrous alloys.

GRAY-SYRACUSE, INC.
107 N. Franklin Street
Syracuse 4, N. Y. Dept. "A"

Please send me literature on Precision Investment Castings.

NAME .....

COMPANY .....

ADDRESS .....

CITY .....ZONE.....STATE.....

News of...

ENGINEERS COMPANIES SOCIETIES

affiliate, whose offices will be maintained with Chemsteel at 5428 Walnut St., Pittsburgh, will specialize in design, construction and maintenance of industrial furnaces.

The purchase of the business and assets of *Mills Alloys, Inc.,* Los Angeles, Calif., has been announced by *Victor Equipment Co.,* San Francisco 7, Calif. The manufacturing facilities will continue to be located at the leased site now occupied by Mills Alloys, and will be designated as the *Alloy Rod & Metal Div.* of *Victor Equipment Co.*

The *Gas Machinery Co.,* Cleveland, Ohio, has appointed *John D. Tebben & Co.,* Detroit, Mich., as sales representative in Detroit and Michigan.

Societies and Schools

Sherwood L. Young, of the C. F. Church Manufacturing Co., was elected chairman of the New England Section of the *Society of the Plastics Industry* for the forthcoming year.

The *University of Massachusetts School of Engineering* has received a $1,500 award from the Research Corp. of New York, to be used to investigate yielding in mild steel and soft iron.

Election of officers and trustees of the *Metal Treating Institute* for the coming year include the following: president—Fred Heinzelman, Jr., Fred Heinzelman & Sons; vice president—John Wolf, Dura-Hard Steel Treating Co.; and treasurer—Paul J. Seitz, Commercial Steel Treating Co.

New York University, in cooperation with the *Atomic Energy Commission,* will hold for the first time a three-day conference on industrial and safety problems of nuclear technology. Scheduled to be conducted Jan. 10-12, 1950, at the New York University, the conference will be the first of its kind in the area of industrial applications of nuclear technology.

The 1949 Medal for the Advancement of Research was presented by the *American Society for Metals* to Fred H. Haggerson, president of Union Carbide & Carbon Corp., at the annual banquet of the Society. The citation was awarded to Mr. Haggerson for being an outstanding example of the modern executive in a manufacturing enterprise, employing industrial research (particularly metallurgical in nature) as an effective aid in the achievement of commendable business objectives.

(More News on page 156)

CHECK the Soil
CHECK the Metal
MAIL the List

OAKITE PRODUCTS, INC.
32H Thames St., N. Y. 6, N. Y.

Tell me (without obligation) about Oakite methods for removing soils checked below:

- ☐ buffing compound residues
- ☐ pigmented drawing compounds
- ☐ oils and greases
- ☐ heat scale
- ☐ tarnish
- ☐ rust
- ☐ carbon smuts
- ☐ flux residues
- ☐ rust preventives
- ☐ other soils: .....

.....

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Metals to be cleaned: .....

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NAME.....

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COMPANY.....

ADDRESS.....

If you haven't been getting satisfactory removal of certain soils, let us show what we can do. There is an effective Oakite method for every metal-cleaning job.

Cleaning in tanks
Cleaning in machines
Electrocleaning
Pre-paint treatment
Steam-gun cleaning
Pickling
Burnishing
Barrel cleaning
Paint stripping
Rust prevention

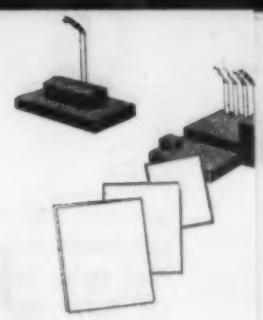
SPECIALIZED INDUSTRIAL CLEANING

OAKITE

TRADE MARK REG. U. S. PAT. OFF.

MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada



MANUFACTURERS' LITERATURE

Materials

Iron and Steel

Stainless Steel. Seven "Industry Booklets" available from Allegheny Ludlum Steel Corp. discuss the use of stainless steel in the chemical, petroleum, brewing, food processing, dairy, laundry and meat industries. In addition to information on corrosion resistance, fabrication and available forms, the booklets stress grade selection for specific applications. (1)

Steel Design. A 72-page booklet published by Climax Molybdenum Co. contains information on the design, selection and treatment of steel components to give a specified service at minimum cost. The book also includes important metallurgical data compiled from a designer's viewpoint. (2)

Gray Cast Iron. Gray Iron Founders' Society, Inc. is offering a booklet containing information on the mechanical and engineering characteristics of gray cast iron. Details for designing cast components are also included. (3)

Stainless-Clad Steel. Detailed corrosion resistance data on various types of stainless steel cladding when used with a great variety of substances is included in a 28-page booklet issued by Jessop Steel Co. High temperature properties, fabricating techniques, specific applications and available sizes of this company's Stainless-Clad Steel are also covered. (4)

Free-Cutting Steel. The new "E" steel produced by Jones & Laughlin Steel Corp. is the subject of an 8-page folder just released. Machinability of this free-cutting steel is as much as 25% better than that of comparable grades of old-type Bessemer stock, and finish is also better. Tool life increases up to 200% have been reported. (5)

Malleable Iron Castings. Grades, design data and applications of malleable iron castings are discussed in this 8-page reprint being offered by Malleable Founders Society. Design data include recommended radii of fillets on ribs and sections, allowable rib and section thicknesses, and factors concerning design of cored parts. (6)

Meehanite Castings. A detailed tabular summary listing the physical properties of the general engineering types of Meehanite castings produced by the Meehanite Metal Corp. is featured in this 4-page, illustrated bulletin, No. 32. (7)

Cold-Rolled Specialty Steels. Uniform hardness, accurate size, high fatigue life and a fine surface are characteristic of the special cold-rolled steels produced by Sandvik Steel, Inc. and described in this 4-page folder. These special steels can be supplied as rolled, annealed or hardened and tempered. (8)

Stainless Steel. Two booklets containing extensive information on stainless steel can be obtained from United States Steel Supply Co. They are entitled "Introduction to Stainless Steel" and "Fabrication of Stainless Steel." (9)

Nonferrous Metals

Welding and Brazing Aluminum. A comprehensive, 132-page manual on welding and brazing of Alcoa aluminum is available from Aluminum Co. of America. Specific instructions for all the widely used welding processes are included, and the text is supplemented by a great number of tables, diagrams and photographs. (10)

Bronze Castings. American Non-Gran Bronze Co. has issued a 16-page, illustrated bulletin describing its production of bronze castings. The machining facilities which make possible this company's precision contract manufacturing are pictured, as are a number of parts typical of its production. (11)

Magnesium. Case studies on successful uses of magnesium are presented in a booklet "How Magnesium Pays," circulated by Dow Chemical Co. It describes how magnesium increases efficiency by cutting dead weight to a minimum. (12)

Nonferrous Casting Alloys. The compositions and mechanical properties of High-tensile Bronze, Aluminum Bronze, Composition No. 1 (bronze), Alcop Bronze, Monel Metal, Nickeldur, and Alloy No. 20 (bearing bronze), used in centrifugal castings by Janney Cylinder Co., are given in a new 4-page brochure. (13)

Aluminum Parts and Assemblies. A new folder available from the Industrial Parts Div. of Reynolds Metals Co. discusses a complete aluminum fabrication service which supplies aluminum parts and assemblies to many production lines. The bulletin includes information on plants, and type and range of equipment and services available. (14)

Nonferrous Alloys. A pocket-sized, 44-page handbook, designed to aid in the selection of nonferrous alloys, has just been published by Riverside Metal Co. It includes advantages, applications, composition, forms, properties and manufacturing limits of phosphor bronze, nickel silver, cupro nickel and beryllium copper, as well as special Riverside alloys. (15)

Strip and Sheet Brass. Nine important advantages obtained from using continuous-cast strip and sheet brass produced by Scovill Manufacturing Co. for drawn, formed or stamped parts are listed in this 4-page, illustrated bulletin. Alloys produced by this company are cartridge brass, gilding, commercial bronze, red brass and yellow brass. (16)

Alloyed Iron Castings. Compositions, mechanical properties and uses of eight of the alloyed gray cast irons produced by Superior Foundry, Inc. are listed in this 8-page bulletin, No. S101. The brochure also discusses the advantages of using Superior unalloyed iron, and pictures some of the production facilities of the company. (17)

Nonmetallic Materials

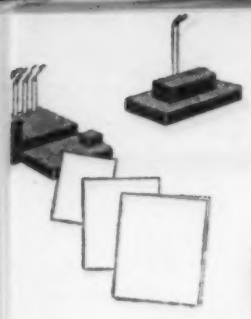
Metal-Clad Plywood. A 20-page, illustrated bulletin prepared by Haskelite Manufacturing Corp. describes the fabrication, fastening and finishing of Plymetl, a metal-clad plywood having high strength and stiffness and higher sound deadening and insulating factors than are found in ordinary structural materials. Many applications are depicted. (18)

High Temperature Cemented Carbides. The physical and mechanical properties of the Grade 138 Series of high temperature cemented carbides known also as "ceramals" or "cermets", produced by Kennametal, Inc., are listed in a 4-page bulletin, No. 255 Supp. 1. General and specific applications are also listed for the seven different grades. (19)

Parts and Forms

Stainless Steel Tubing. An 8-page, illustrated bulletin distributed by J. Bishop &

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 153.



MANUFACTURERS' LITERATURE

Co. Platinum Works lists extensive properties and specifications for its close-tolerance, small-diameter, stainless steel tubing. The cold-drawn tubing, seamless or welded, is available within the range from 0.008- to 1-in. O.D. (20)

Hard Castings. An 8-page bulletin, No. 949, published by Coast Metals, Inc., discusses the numerous applications of its hard castings and hard facing alloys. Some of the rolls, guides, bushings, paddles, blades, etc. used in the metal-working industries are pictured, and the advantages obtained by using Coast metals are supported by actual production figures. (21)

Curved Metal Parts. The Metal Form Div. of Cyril Bath Co. has issued a 12-page, well-illustrated bulletin describing its facilities for producing curved metal parts to order. This company's contract forming methods are particularly suitable to structural and ornamental parts required in modern streamlined light-weight construction. (22)

Magnesium Die Castings. The physical properties, relative weights, typical applications, and numerous advantages of using Doler-Mag magnesium die castings are featured in a 4-page, illustrated bulletin, published by the Doehler-Jarvis Corp. (23)

Plastic-Metal Products. Products of the Bay Manufacturing Div. of Electric Auto-Lite Co. are illustrated in color in a new 16-page bulletin. Emphasizing the combination of plastics and metals in small parts, the booklet also pictures decorated metal products and functional, decorative and rubber-like plastic parts. (25)

Gray Iron Castings. A 36-page booklet illustrating the mechanized facilities of Forest City Foundries Co. has just been released. Among the equipment, designed to produce high-quality gray iron castings, which is described in this new brochure is an automatic conveyor heat treating furnace. This assures uniform heat treatment at reasonable cost. (26)

Castings. Howard Foundry Co. has prepared an extensively illustrated, 72-page booklet describing its facilities for producing castings of high quality. Properties of its aluminum, magnesium, semi-steel, bronze, brass and Electric Alloy Steel castings are also listed. Among the most recent alloys cast by this company are the British magnesium-zirconium alloys, Z5Z and ZREI. (27)

Cold-Drawn Shapes and Shells. a 2-page bulletin prepared by Linde Air Products Co. discusses the types of Prest-O-Lite cold-drawn shapes and shells that can be supplied. Materials drawn and the dimensional range of shapes possible are also given. (28)

Friction-Minimizing Bearings. A complete line of friction-minimizing, self-lubricating Morganite bearings, including metallic and nonmetallic content bearings, composite bearings and machined or molded shapes of special-quality, self-lubricating materials, is fully described and illustrated in a 6-page folder released by Morganite, Inc. (29)

Powder Metallurgy Parts. A 4-page, illustrated bulletin, No. 567, issued by the Plastic Metals Div. of National Radiator Co., discusses the types of parts fabricated from powders of various metals, and pictures a large number of specific products. Although this division does not fabricate metal powder parts commercially, its long experience with metal powders enables it to solve many problems in this field, including the blending of powders and additives according to customers' requirements. (30)

Zinc Alloy Die Castings. The more salient features of Zamak-3 and Zamak-5 zinc alloy die castings, the method of production, and typical applications are all reviewed in this 28-page, illustrated booklet, available from the New Jersey Zinc Co. (31)

Seamless Mechanical Tubing. A 36-page technical handbook, No. M-1, on seamless mechanical tubing of carbon and alloy steels is available from Ohio Seamless Tube Co. The booklet contains composition limits, tolerances, available sizes, machining practice, testing methods, mill practices, etc. (32)

Powdered Metal Parts. Latest developments in powder metallurgy, which have led to whole new fields of application for Powdermet parts, are discussed in a new booklet released by Powdered Metal Products Corp. of America. Included is a description of the new Powdermet process, copper filling, which permits economical production of parts previously almost impossible to make. (34)

Welded Mechanical Tubing. The Steel & Tubes Div. of Republic Steel Corp. has prepared an 8-page bulletin on Electrunite, electric welded mechanical tubing of carbon, alloy and stainless steels. The Electrunite Process results in uniformity of strength, dimensions, workability and appearance. (35)

Industrial Main Springs. A 4-page folder describing the industrial main spring production of Sandsteel Spring Co., Inc. is now available. The company's special equipment is geared to handle small as well as large orders for flat springs with equal facility. (36)

Powder Metallurgy Parts. An interesting 36-page booklet offering a brief, but broad, view of the powder metallurgy field has been released by F. J. Stokes Machine Co. The bulletin includes a description of the powder metallurgy process; a series of 10 case histories demonstrating typical applications; a discussion of several unique applications; mechanical properties; design principles; and a survey of development and future potentialities. (37)

Seamless Steel Tubes. An 8-page, illustrated brochure prepared by the Steel & Tube Div. of Timken Roller Bearing Co., lists size ranges and characteristics of this company's hot-finished, cold-drawn, turned, centerless ground and Rotorolled seamless steel tubing. The diversified uses for mechanical tubing are also indicated. (38)

Steel Castings. A 4-page, illustrated folder, No. 649-S, describes the advantages offered by Unitcastings, high-quality steel castings produced by Unitcast Corp. This company utilizes careful metallurgical laboratory control to produce heats consistently qualified, both chemically and physically, to meet customers' specifications. (39)

Weldments. The advantages of using welded steel construction in the design of machine bases and other supporting units are covered in a new 16-page bulletin published by Van Dorn Iron Works Co. This company's facilities for producing such structures are also discussed and illustrated. (40)

Coatings and Finishes

Metallizing for Corrosion Protection. Examples of a variety of iron and steel equipment that were metallized with either zinc or aluminum, thus affording 15 to 20 years of protection against rust and corrosion, are described and illustrated in this 8-page bulletin, No. 62, offered by the Metallizing Engineering Co., Inc. (41)

Hard-Facing. Use of hard-facing alloys produced by Mir-O-Col Alloy Co. for grader blades, bucket teeth, ore buckets and other applications is discussed in this 4-page, illustrated brochure. Case histories show tremendous increases in life resulting from use of these wear-resistant overlays. (42)

Hard-Facing Alloys. An 8-page summary of the properties and applications of 10 hard facing alloys is available from Wall-Colmonoy Corp. The illustrated catalog, No. 76, also contains detailed descriptions of the furnace, spray, oxyacetylene and electric weld processes by which these hard overlays are applied. (43)

Methods and Equipment

Heat Treating and Heating

Controlled Atmosphere Furnace. The principles of operation, constructional features and specifications of a controlled atmosphere furnace that meets every heat treating problem on all types of steel are in-

MANUFACTURERS' LITERATURE

nuts and lock washers. (64)

Welding Stainless Steel. Westinghouse Electric Corp. has issued an 8-page, illustrated bulletin, No. B-4292, which classifies its Flexarc stainless steel electrodes for welding chromium-nickel and straight chromium steels. Specific applications of some of these electrodes are described and instructions on welding procedures are included. (65)

Forging and Forming

Coil Weight Calculator. Follansbee Steel Corp. is offering a handy, circular calculator for determining the weight of the coils of strip fed into automatic production devices. The calculator is similar to a circular slide rule. (66)

Precision Metal Forming. A highly efficient method of forming sheet metal, called the Marform Process, is covered in a 4-page, illustrated bulletin distributed by Glenn L. Martin Co. This process materially reduces the time and cost required by certain manufacturing operations, and makes possible economical production of complex sheet metal parts. (67)

Die-Less Duplicating. A new 40-page catalog, No. 49-15, covers a process for duplicating parts to die accuracy without incurring the time delay and expense of dies by using Di-Acro Precision Machines. Produced by O'Neil-Irwin Manufacturing Co., these forming machines are described in detail in this booklet. (68)

Metal Spinning. "Phoenixspun" methods, which solve a wide range of forming and fabricating problems, are discussed in a 4-page, illustrated bulletin prepared by the Metal Spinning Div. of Phoenix Products Co. It describes the spinning of particular components from aluminum, copper and stainless steels. (69)

Hole Punching Units. The Wales-Strippit Corp. has published a 16-page bulletin, No. CJ, describing and illustrating its complete line of Type "CJ" hole punching units for punching mild steel up to 1/4-in. thick. Specifications and helpful diagrams are included. (70)

Adjustable Perforating Dies. Specifications and prices of a complete line of adjustable perforating dies for perforating materials up to and including 1/8-in. mild steel are included in this compact, 40-page, illustrated catalog, No. 48, published by S. B. Whistler & Sons, Inc. (71)

Machining

Sintered Carbide Tips, Tools, Etc. Specifications and prices of a complete line of Firthite sintered tungsten carbide tips and tools, boring bits, Mechanigript adjustable tool holders, and special tips, nibs and wear parts made to customers' specifications are featured in this 28-page, illustrated catalog, No. FE-127, offered by the Firth Sterling Steel & Carbide Corp. (72)

Continuous Milling. Precision Shapes, Inc. has released a 4-page bulletin describing the kind of results that can be obtained from its patented continuous milling process. Since this process can be adopted to a limitless variety of shapes and profiles, it allows the engineer increased freedom in design. (73)

Melting, Casting and Molding

Precision Investment Casting. The Micocast Process, a precision investment casting technique which makes possible the production of more intricate parts using better alloys, is the subject of a 2-page bulletin issued by the Microcast Div. of Austenal Laboratories, Inc. Sound structure and a high degree of surface smoothness result from this process. (74)

Precision Casting. A 6-page reprint covering the production of precision castings by the Mercast Process, which utilizes frozen mercury patterns, is being circulated by National Bronze & Aluminum Co. This company can produce castings weighing up to 60 lb. with tolerances of ±0.0015 in. per in. using this process. (75)

Investment Casting. Precision Metalsmiths, Inc. are offering a 4-page reprint describing the process which has achieved great savings by replacing complex assemblies by a single investment casting. Detailed production data illustrate the savings obtained on two specific parts—a shuttle lifter and a shuttle feeder. (76)

Inspection and Control

Spring Tester. An instrument designed for the fast and accurate testing of compression and extension springs is described in a 4-page bulletin, No. 302, issued by Baldwin Locomotive Works. The Baldwin-Hunter tester has a load capacity of 5 lb., and measures the length of springs up to 12 in. at a specified load. (77)

Temperature Controls. A large variety of custom-built or production models of temperature control instruments for every type of application are described and illustrated in this 8-page bulletin, issued by Burling Instrument Co. (78)

Pyrometer Indicator. Technical features and prices of several models of pyrometer indicators for various temperature ranges are listed in a new 4-page catalog, Section 25, distributed by Thermo Electric Co. The compact assembly of pyrometer and connector panel provides for rapid indication of temperatures at from one to six thermocouple locations. (79)

Testing Machines. Four new developments in the testing equipment field are described in the 3-page first issue of *Tinius Talks,* published by Tinius Olsen Testing Machine Co. The bulletin covers: low load ranges for "L" Type hydraulic testing machines; a new Electronic Recorder; a new LC Type testing machine; and a new Electrodyne Indicator, Type EAA for Olsen Type E-O balancing machines. (80)

Combustion Safeguard. The new Model 1300 Flame-otrol combustion safeguard is described in a 4-page bulletin, No. F2-1, prepared by Wheelco Instruments Co. It is designed as a safety device for industrial and commercial fuel-fired furnaces, ovens, boilers, kilns and other heating equipment. (81)

General

Vibration Isolation. Multiplane shear-type bonded rubber mountings for isolating vibration from all directions are described in a 12-page, illustrated bulletin, No. 106, released by Lord Manufacturing Co. Theory of operation, specifications, and selection and installation information are presented. (82)

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cluded in this 16-page, illustrated bulletin, released by the Delaware Tool Steel Corp. (44)

Surface Heating. This 12-page, illustrated bulletin, No. GET-1743, published by General Electric Co., describes a wide variety of heaters used for injection-molding machines, die heating, molding presses, rubber-molding machines, roll heating, aluminum extrusion, and many other applications. A section demonstrating the calculation of heating requirements is also included. (45)

High Temperature Electric Tube Furnace. Bulletin No. 1148, published by the Harper Electric Furnace Corp., describes and illustrates a high temperature electric tube furnace especially designed for general research work. A useful chart of typical heating and cooling curves is included. (46)

Steel Treating. This 12-page, illustrated bulletin describes the facilities of Lakeside Steel Improvement Co. for flame hardening, induction hardening, heat treating, normalizing, Chapmanizing, nitriding, carburizing, annealing, cyaniding, sand blasting, straightening and inspection and testing of steel. (47)

Heat Treating Furnaces. The Industrial Heating Div. of Westinghouse Electric Corp. has issued an 8-page, illustrated bulletin. No. B-4054, describing its various types of gas-fired heat treating furnaces and their applications. Actual installations are pictured and explained. (48)

Cleaning and Finishing

Rust Remover. Five outstanding advantages received when using Diversey Everite for safely removing rust, heat scale, hard water scale and discolorations from metal surfaces are listed in this single, illustrated sheet issued by the Diversey Corp. (49)

Metal Finishing. The October, 1949 issue of *Modern Metal Finishing*, containing six illustrated articles, is available from E. I. du Pont de Nemours & Co. (Inc.). Among developments described are: vapor degreasing; carbonate removal from "Coppralyte" copper plating baths; sodium hydride descaling; free-washing carburizing baths; vapor cleaning of metal moldings; and a new copper-plating filter aid. (50)

Analyzing Plating Solutions. Hanson-Van Winkle-Munning Co. has issued a revised edition of its bulletin describing simple methods for analyzing plating solutions. Regarded as a standard text by the electroplating industry, this book is especially useful to those who, in doing their own solution analysis, wish to avoid the complications of the more involved methods. (51)

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MANUFACTURERS' LITERATURE

Plating Barrels. A 4-page, illustrated bulletin issued by Chas. F. l'Hommedieu & Sons Co. describes the important features of the Reliance horizontal, mechanical plating barrel. In addition to easier handling, this new equipment offers a saving in time required to raise and lower the cylinder. (52)

Liquid Blast Cleaning. Hydro-Finish, the liquid blast cleaning method of Pangborn Corp., is described in Bulletin No. 1400. Hydro-Finish assures better bonding, makes threaded pieces turn more easily, eliminates burrs, and removes or blends grinding lines. Treated surfaces electroplate better and resist peeling. (53)

Surface Finishing Machines. An 8-page, illustrated bulletin released by Production Machine Co. describes the characteristics and applications of five types of surfacing machines. Centerless polishing and buffing machine, straight line finishing machine and horizontal wet surfacers are included. (54)

Welding and Joining

Inert Gas Arc Welding. Heliwelding, an inert-gas, shielded-arc welding process, is the subject of a new 16-page booklet, No. ADC 709, published by Air Reduction Sales Co. The booklet describes the process and its application, and includes sections on manual, semi-automatic and automatic operation. More than 25 photographs, sketches and tables are used to illustrate the bulletin. (55)

Stainless Steel Fasteners. All types and sizes of stainless steel machine, self-tapping socket, set and wood screws, and nuts, bolts, washers, rivets and pins are described and illustrated in bulletin No. 49E, offered by Allmetal Screw Products Co. (56)

Welding Electrodes. A comprehensive catalog, No. 49A, listing physical properties, chemical analysis of deposit, welding procedure, available sizes and recommended current values, and typical applications for all Champion Rivet Co. electrodes has just been issued. The large number of electrode types are carefully classified as to main fields of application in this 32-page booklet. (57)

Arc Welding Accessories. Descriptions, specifications and prices of more than 150 arc welding accessories are contained in a 20-page catalog, No. GEC-253A, announced by General Electric Co. Although the catalog does not include all the accessories furnished by the company, the products listed meet the requirements of all ordinary welding work. (58)

Brazing. The use of Easy-Flo or Sil-Fos in brazing joints in the hydraulic shock strut of an aircraft landing gear, copper tanks, radio components, and robot milkers is described in *Low Temperature Brazing News*, No. 47, prepared by Handy & Harman. (59)

Special Nails, Rivets, Screws. John Hassall, Inc. offers a bulletin describing its complete line of special nails, rivets and screws, made in diameters from 1/32 to 3/8 in. and lengths up to 7 in., in a variety of metals and finishes. (60)

Welding Fasteners and Fittings. A wide variety of applications for the numerous fasteners and fittings produced by Ohio Nut & Bolt Co. for projection and spot welding are illustrated in this new 4-page bulletin, No. 496. Use of end weld studs for projection welding is also shown. (61)

Self-Locking Nut. The new type 6NAO Palnut, which has a triple grip on the bolt thread, is the subject of a 4-page, illustrated bulletin, No. 550, prepared by Palnut Co. The new nut can be locked anywhere on the bolt, and saves 60 to 70% in weight compared with other devices. (62)

Nuts. This new catalog, No. 235, features 20 pages of pictures and diagrams showing the numerous applications of Speed Nuts in a wide range of commercial equipment. These nuts, manufactured by Tinnerman Products, Inc., provide double-locking spring tension assembly, fit any type screw or bolt, and are designed to replace threaded

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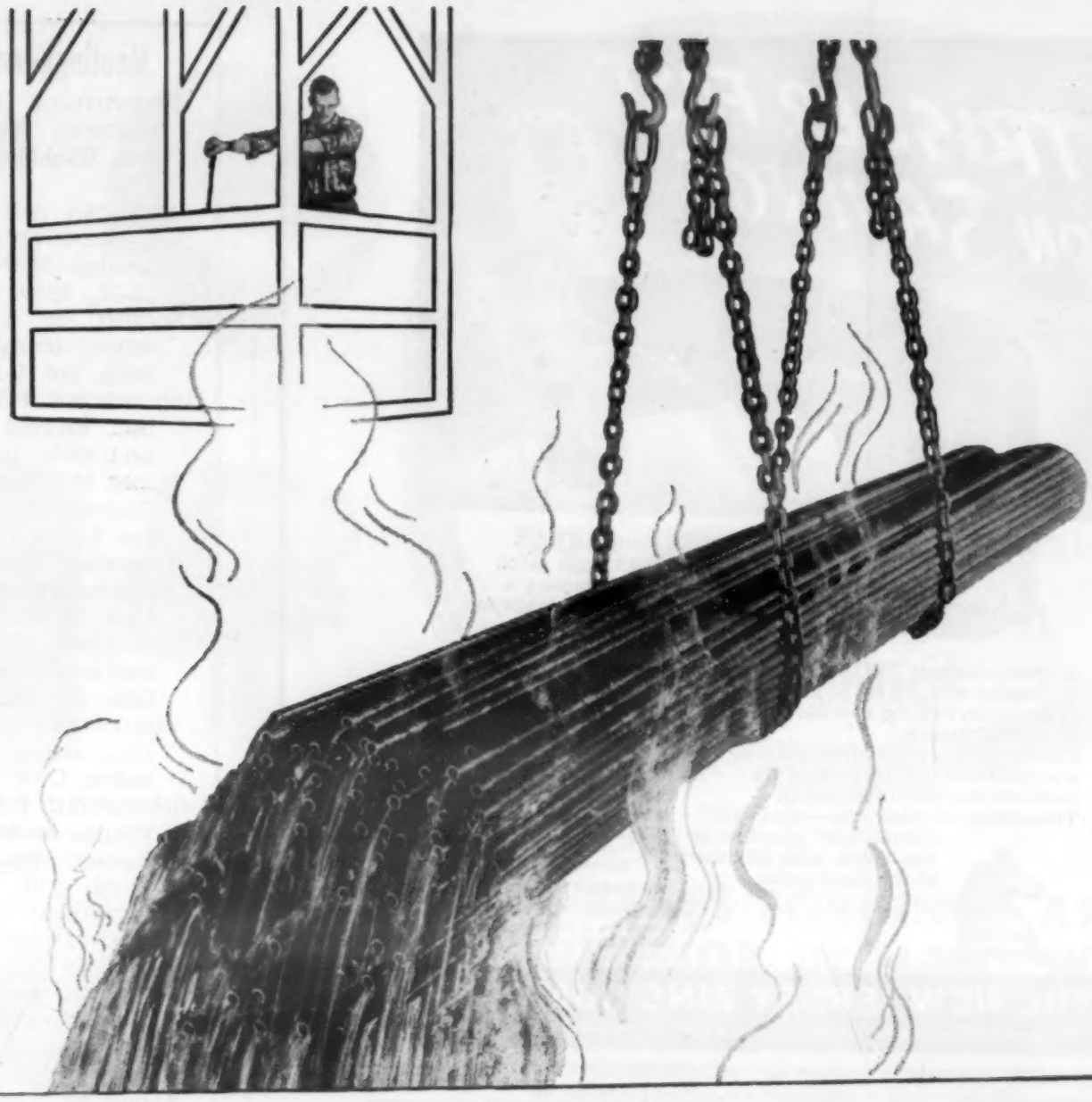

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Meetings and Expositions

INSTITUTE OF THE AERONAUTICAL SCIENCES, Wright Brothers Lecture. Washington, D. C., Dec. 17, 1949.

AMERICAN ASSOCIATION FOR ADVANCEMENT OF SCIENCE, annual meeting. New York, N. Y. Dec. 26-31, 1949.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit, Mich. Jan. 9-13, 1950.

SOCIETY OF PLASTICS ENGINEERS, INC., national conference. Cleveland, Ohio. Jan. 11-13, 1950.

PLANT MAINTENANCE SHOW AND CONFERENCE. Cleveland, Ohio. Jan. 16-19, 1950.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting. New York, N. Y. Jan. 18-20, 1950.

MALLEABLE FOUNDERS' SOCIETY, semi-annual meeting. Cleveland, Ohio. Jan. 20, 1950.

INSTITUTE OF SCRAP IRON & STEEL, INC., annual convention. Washington, D. C. Jan. 22-24, 1950.

INDUSTRIAL FURNACE MANUFACTURERS ASSOCIATION, midwinter meeting. Dearborn, Mich. Jan. 23-24, 1950.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York, N. Y. Jan. 23-26, 1950.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, annual meeting. Dallas, Tex. Jan. 23-27, 1950.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, winter meeting. New York, N. Y. Jan. 30-Feb. 3, 1950.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York, N. Y. Feb. 12-16, 1950.

AMERICAN SOCIETY FOR TESTING MATERIALS, committee week and spring meeting. Pittsburgh, Pa. Feb. 27-Mar. 3, 1950.

STEEL FOUNDERS' SOCIETY OF AMERICA, annual meeting Chicago, Ill. Mar. 21-22, 1950.

SOCIETY OF THE PLASTICS INDUSTRY, national meeting. Chicago, Ill. Mar. 28-31, 1950.

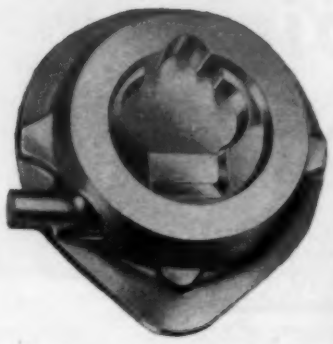
NATIONAL ASSOCIATION OF CORROSION ENGINEERS, annual conference and exhibition. St. Louis, Mo. Apr. 4-7, 1950.

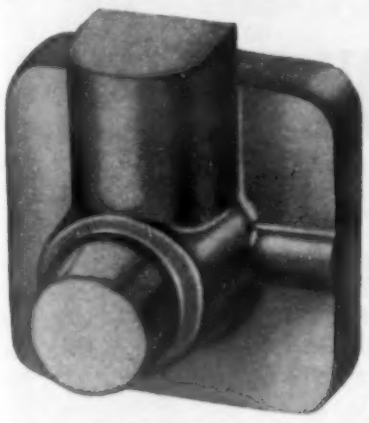
AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth conference and Blast Furnace, Coke Oven and Raw Materials conference. Cincinnati, Ohio. Apr. 10-12, 1950.

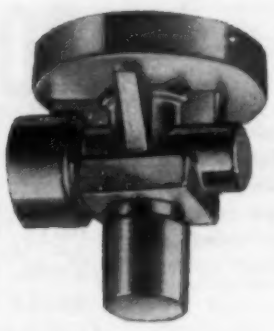
AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. Philadelphia, Pa. Apr. 10-14, 1950.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Washington, D. C. Apr. 12-14, 1950.

AMERICAN SOCIETY OF CIVIL ENGINEERS, spring meeting. Los Angeles, Calif. Apr. 19-21, 1950.

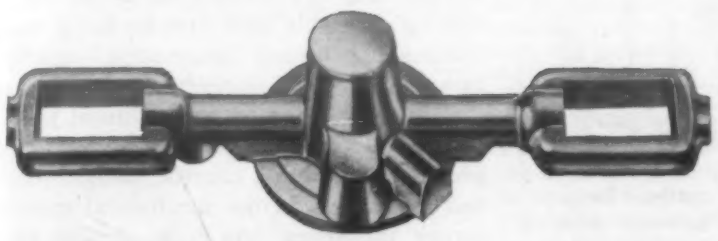






BRASS FORGINGS

are the answer where non-corroding, non-porous materials of great strength are essential

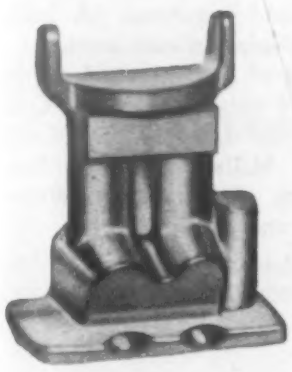


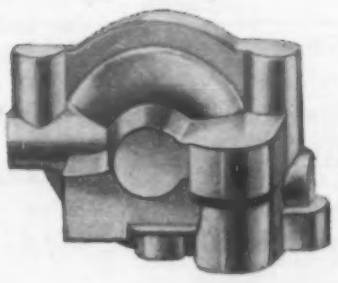
BRASS FORGINGS ARE SUPERIOR IN MANY WAYS TO SAND CASTINGS

LOWER COST: The combination of smoother surfaces, absence of porosity, better machinability, longer tool life, less chucking difficulty, closer tolerances, fewer operations, lighter weight, and practically no scrap, results in the production of a superior product at a lower cost.

Forgings possess about twice the tensile strength of sand castings. Extreme pressures under which the forgings are produced, once during extrusion and again during forging, assures a dense, close-grained material.

Due to the absence of scale, sand, etc. in the metal, forgings can be machined at a higher rate of speed than similar parts made by other processes, and the smoothness of surface, combined with close tolerances, frequently eliminates machining operations. The life of machine tools is greatly increased.





COMPARISON OF COST OF AVERAGE BRASS FORGINGS AND BRASS CASTINGS

(Quoted Figures are approximate)

Machined — Ready to polish, buff and plate	FORGINGS COST 20% LESS	
Polish and Buff	FORGINGS COST 50% LESS	
Scrap after Polishing and Buffing	CASTINGS 7%	FORGINGS 0

The Mueller Brass Co. is equipped to forge, completely machine, polish, buff, lacquer or plate. Let us quote you on your product in Forged Brass.

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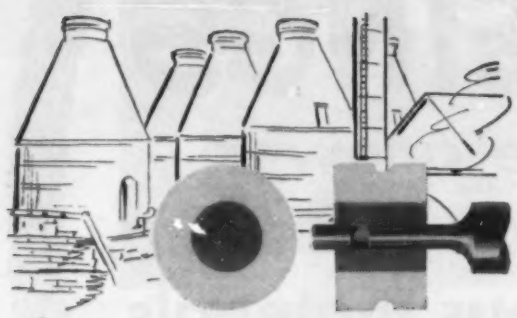
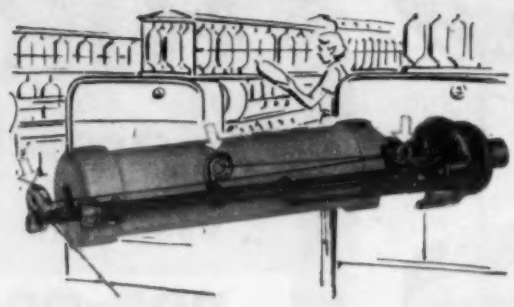
PORT HURON, MICHIGAN

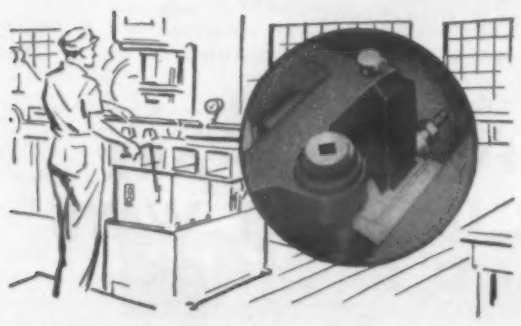
You find CARBOLOY CEMENTED CARBIDE doing the most amazing jobs!



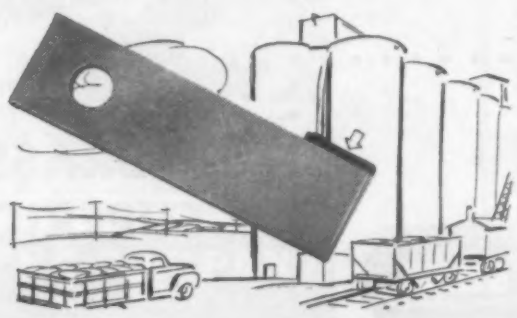
IN CERAMICS MANUFACTURING—dies of Carboloy Cemented Carbide are used to great advantage in moulds for highly abrasive ceramics materials. Through use of wear-resistant Carboloy inserts in moulds, one manufacturer boosted production from 700 to 100,000 pieces!



IN THE TEXTILE INDUSTRY—abrasive wool, nylon and other threads, continually rubbing against thread-eyes, *wore them down rapidly.* Carboloy thread-eyes, which replaced ceramic guides, *showed no signs of wear after a whole year of use.* They have lasted up to 100 times longer!



IN MACHINE TOOLS—bearing surfaces of cast iron and steel, on a grinding machine for grinding form tools with diamond wheels, had to be resurfaced every six months. After Carboloy Cemented Carbide was substituted, no wear signs had been detected after more than a year of continuous use.



IN FOOD PROCESSING (for cattle)—long-wearing Carboloy blades, in hammer mills used in processing livestock food, have greatly outlasted blades of finest steel which were previously used. And the Carboloy-equipped hammer mills are producing a more uniform and higher-quality feed.

If you have a "wear" problem . . .

SURPRISED to find Carboloy Cemented Carbide at work in such a variety of ways? Actually, these are only a few of the hundreds of unusual jobs this versatile metal is doing . . . and *well.*

Because Carboloy—*the hardest metal made by man*—has such high resistance to wear, design engineers in countless industries have found it the answer for licking abrasive, corrosive, or erosive wear on machines or parts. Nowadays, Carboloy is used for everything from dental drills to draw dies and from bushing inserts to brick mold liners.

If wear is causing excessive down-time and costly loss of production, if rejects are high or replacements too frequent, why not let Carboloy's engineers give you a hand with your problem?

It's a good bet they'll come up with a solution that will mean longer life and better operation for equipment or parts . . . and real savings for you.

Delay in taking action may cost you time and money. So, if you have a wear problem, or a product or part that might be benefited by Carboloy, put in that call for a Carboloy expert.

CARBOLOY COMPANY, INC.
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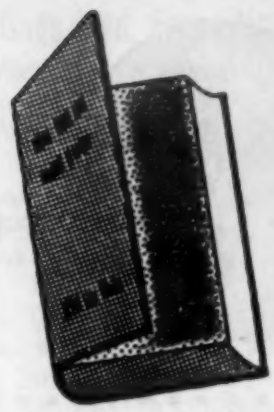
CARBOLOY®
CEMENTED CARBIDE

THE HARDEST METAL MADE BY MAN



BOOK REVIEWS

ASTE Handbook

TOOL ENGINEERS HANDBOOK. *Prepared by the American Society of Tool Engineers. Published by McGraw-Hill Book Co., New York, 1949. Cloth, 6¼ by 9¼ in., 2070 pages. Price $15.00.* This handbook has been planned to integrate and condense the widely scattered technical data developed by the Society's 18,000 members, the operating methods and standards of manufacturers, national association standards, proceedings of engineering societies, and findings published by the technical press.

It is a comprehensive reference on all phases of planning, control, design, tooling and operations in the mechanical manufacturing industries. As such, it will be of use not only to the tool or production engineer, but also to non-engineering management.

The handbook is split down into 115 different sections, each illustrated with graphs, tables and diagrams. A bibliography is also included in each section.

An indication of the scope of the book is given by a few section headings: Quality Planning and Control; Metal Mold Casting; Vertical Boring Mills and Turret Lathes; Bandsaw Friction Cutting; Arc Welding; Sleeve Bearings and Bushings; etc.

Light Metals

TECHNOLOGY OF LIGHT METALS. *By A. von Zeerleder. Published by Elsevier Publishing Co., Inc., New York 3, N. Y., 1949. Cloth, 7 by 10⅛ in., 366 pages. Price $6.00.*

The increasing use of the light metals in industry makes this new text a welcome addition to the existing literature on aluminum and magnesium. The author has confined his attention to these two metals because of the negligible industrial importance of the other light metals. Actually, this book is an outgrowth of the author's earlier "The Technology of Aluminum and Its Light Alloys." In this new reference he includes magnesium, though the space devoted to magnesium is restricted somewhat, corresponding to its relatively lesser importance at the present time.

The fact that the book has been translated

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roducts for the Iron and Steel Industries

PRODUCT	TYPICAL COMPOSITION	APPLICATIONS
ALSIFER	Aluminum.....20% Silicon.....40% Iron.....40%	Used principally as a steel deoxidizer and for grain size control.
FERRO CHROMIUM High Carbon Grade	Chromium....66-70% Carbon.....4-6%	For wrought constructional steels and steel and iron castings.
Iron Foundry Grade	Chromium....62-66% Carbon.....4-6% Silicon.....6-9%	For alloyed cast irons. Readily soluble as a ladle addition at the lower temperatures of cast iron.
Low Carbon Grades	Chromium....67-72% Carbon...06%, .10%, .15%, .20%, .50%, 1.00% and 2.00% max.	For low carbon chromium steels, especially those with high chromium content, such as stainless and heat-resistant types.
FERRO SILICON 25-30% Grade	Silicon.....25-30%	Deoxidizer for open hearth steels; also for high silicon, corrosion-resistant iron castings.
50% Grade	Silicon.....47-52%	Used as a deoxidizer and for the addition of silicon to high silicon steels, for springs, electrical sheets, etc. Pulverized form used as ladle addition to cast irons for silicon content and graphitization control.
75% Grade	Silicon.....74-79%	For high content silicon steels, such as spring steels, sheets and forgings of high magnetic qualities for electrical apparatus.
High Silicon Grades 80-85% 85-90% 90-95%	 Silicon.....80-84.9% Silicon.....85-89.9% Silicon.....90-95%	 For high content silicon steels where small ladle additions are used for required silicon content. Also for manufacture of hydrogen by reaction with caustic soda and production of magnesium by the Pidgeon process.
FERRO TITANIUM High Carbon Grade	Titanium.....15-18% Carbon.....6-8%	Final ladle addition to control "rimming" action and to clean effervescing steel. Final deoxidizer and scavenger for steel castings and fully killed ingot steels.
Medium Carbon Grade	Titanium.....17-21% Carbon.....3-4.50%	Often preferred to the High Carbon Grade as a final ladle addition to very low carbon rimming or effervescing steels.
Low Carbon Grades 20-25% Ti Grade	Titanium.....20-25% Carbon...max. 0.10% Silicon.....max. 4% Aluminum max. 3.50%	Carbide stabilizer in high chromium corrosion-resistant steels of extremely low aluminum content. Deoxidizer for some casting and forging steels.
40% Ti Grade	Titanium.....38-43% Carbon...max. 0.10% Silicon.....max. 4% Aluminum...max. 8%	Carbide stabilizer in high chromium corrosion-resistant steels, where smaller ladle additions are desired and extremely low aluminum content is not essential.
ALUMINUM	Aluminum ... 85-99%	For deoxidation and grain size control of steel. (Ingot, shot, grain and special shapes.)
VANADIUM METAL		For iron-free, low-iron, or low-impurity alloys.
90% Grade	Vanadium 91%	
95% Grade	Vanadium 95%	
99.7% Grade	Vanadium 99.7%	

PRODUCT	TYPICAL COMPOSITION	APPLICATIONS
FERRO VANADIUM Iron Foundry Grade	Vanadium....38-42% Silicon.....7-11% Carbon.....about 1%	For iron foundry use. Imparts remarkable improvement in physical properties with no sacrifice of machinability; highly soluble, insuring complete diffusion.
Grade "A" (Open Hearth)	Vanadium....35-45% 50-55% Silicon...max. 7.50% Carbon...max. 3.00%	For low percentage vanadium content of rolled, forged or cast constructional steels. Also used in vanadium cast irons.
Grade "B" (Crucible)	Vanadium....35-45% 50-55% Silicon...max. 3.50% Carbon...max. 0.50%	For tool steels and special high vanadium steels in which required limits for carbon and silicon are narrow.
Grade "C" (Primos)	Vanadium....35-45% 50-55% 70-80% Silicon...max. 1.25% Carbon...max. 0.20%	For tool steels and special steels requiring high percentages of vanadium and exceptionally low carbon and silicon content.
VANADIUM PENTOXIDE Technical Grade Fused Form	V_2O_5..88-92%	A source of vanadium in basic electric furnace steels. A base for numerous chemical compounds.
Technical Grade Air Dried Form	V_2O_5.....83-85%	A base for preparation of numerous chemical compounds (catalysts, etc.).
GRAINAL ALLOYS Vanadium Grainal No. 1	Vanadium....25.00% Aluminum....10.00% Titanium.....15.00% Boron.....0.20%	Practical and economical intensifiers for controlling and increasing the capacity of steels to harden, and for improving other important engineering and physical properties.
Vanadium Grainal No. 6	Vanadium....13.00% Aluminum....12.00% Titanium.....20.00% Boron.....0.20%	See above.
Grainal No. 79	Aluminum....13.00% Titanium.....20.00% Zirconium.....4.00% Manganese....8.00% Boron.....0.50% Silicon.....5.00%	See above.
GRAPHIDOX No. 4	Silicon ..... 48-52% Titanium..... 9-11% Calcium 5-7%	For graphitization of iron; ladle treatment insures normal graphite, free from dentritic structure; reduces chill; efficient inoculant in production of high strength irons.
V-FOUNDRY ALLOYS V-5 Grade	Chromium....38-42% Silicon.....17-19% Manganese....8-11%	Used in cast irons as a ladle addition. Reduces chill, promotes uniformity of structure, increases strength and hardness.
V-7 Grade	Chromium....28-32% Silicon.....15-21% Manganese...14-16%	See above.
BRIQUETTES Ferro Chromium	Hexagonal. Weigh approx. 3¾ lb. and contain 2 lb. of chromium.	A practical and convenient form for adding ferro-alloys to the cupola.
Ferro Silicon	Two sizes, both cylindrical, one containing 1 lb. of silicon; the other, 2 lb. of silicon.	See above.
MISCELLANEOUS	Special ferro-alloys, metals, chemicals and carbides.	To meet individual requirements.

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If you have a product or production process where conditions of intermittent or continuous high temperatures in oxidizing atmosphere are combined with compressive or tensile loads—KENTANIUM is your metal.

The distinctive advantages of Kentanium (basically titanium carbide) include: Higher strength and resistance to oxidation than cast alloys at 1800° F. and above; high Young's Modulus of Elasticity; and greater thermal shock resistance than ceramics.

Kentanium is made in several different compositions. Each composition has a specific combination of properties that suit it to the needs of a particular high temperature application.

Typical uses where Kentanium excels include thermocouple protection tubes, resistance heating elements, hot working dies, furnace rollers, supporting pins in furnaces, bushing and shear for cutting off hot rod, and many others.

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Application

Book Reviews

(continued)

from the original German presents no great obstacle to the reader. One recurring deviation from our practice is the British spelling of aluminum as "aluminium." More important is the use throughout the book of trade names and alloy designations common to Switzerland. However, a table of comparative designations is included.

A good indication of the wide scope of the book can be found in the following chapter titles: History and Production; Alloys; Properties and Methods of Testing; Design and Construction; Melting Furnaces; Casting; Rolling; Extrusion; Forging; Drawing of Tubes and Sections; Wire Manufacture; Spinning and Press-Work; Thermal Processes; Machining Practice; Soldering and Welding; Riveting; and Surface Treatment. A condensed bibliography which, nevertheless, fills 13 pages is also included.

Weld Design

WELD DESIGN. *By Harry D. Churchill and John B. Austin. Published by Prentice-Hall, Inc., New York, 1949. Cloth, 6 by 8¾ in., 216 pages. Price $6.65.* Recognizing the recent growth of arc welding as a production tool, this book covers the design of welded machine bases from a theoretical and practical standpoint.

Preliminary to a discussion of actual fabrication details, the authors give a practical and concise review of materials used in machine-base construction and a picture of the many methods of processing plates and structural shapes. The peculiar service features of machine bases are also discussed in relation to stress analysis.

Actual design data are accompanied by a great number of explanatory photographs and sketches. In addition to a thorough survey of welding specifications and processes, the authors include a short chapter to demonstrate a method of analyzing the costs of these welding operations.

This simply-written text should prove a worthy supplement to the many existing texts on design of *cast* machine bases.

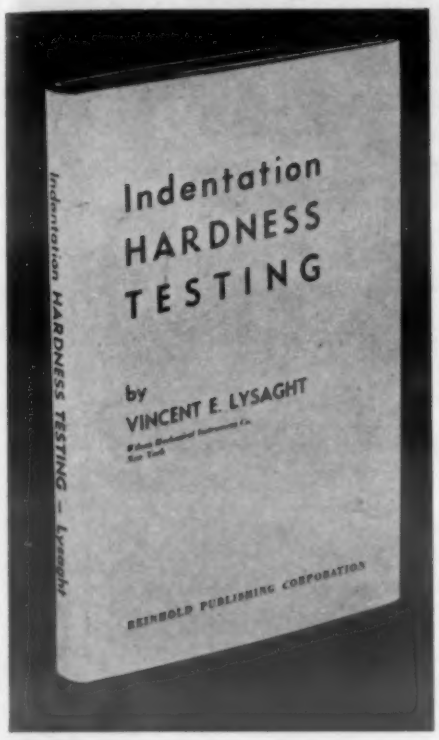
Other New Books

METALLIC CREEP AND CREEP RESISTANT ALLOYS. *By A. H. Sully. Published by Interscience Publishers, Inc., New York, 1949. Cloth, 5¾ by 8¾ in., 278 pages. Price $5.50.* Both the theoretical and practical aspects of metallic and creep resistant alloys are covered.

THE CORROSION OF MILD STEEL BY THE PRODUCTS OF COMBUSTION OF GASEOUS FUELS. *By H. A. Pray, R. S. Peoples, R. S. Dalrymple & C. T. Sims. Published by Battelle Memorial Institute, Columbus 1, Ohio. Paper, 8½ x 11 in., 50 pages. Price 75c.* An engineering study sponsored by the American Gas Association Committee on Domestic Gas Research.

"This book should help provide a clearer understanding of the fundamentals of the subject and may well inspire many to explore further into this useful branch of metallurgy and engineering."

—American Metal Market



290 pages • illustrated • $5.50

Useful, factual and based on up-to-date industrial research practice, this new book covers the many problems involved in the hardness testing of metals and other materials. It describes the instruments in most common use—the Brinell, Rockwell, Scleroscope and Diamond Pyramid, as well as those used for specialized types of hardness tests. The author evaluates the advantages and disadvantages of each test and gives complete specifications for each. He covers the recent advances in the field and the work of present hardness committees of the leading technical societies.

Whether you are a metallurgist, a testing engineer, a machine operator or a student, you will find much of value in this complete story of hardness testing. The more advanced student and research investigator will find sufficient theory to afford a comprehensive basis for practical hardness testing. The plan, scope and simplicity of language make the book admirably suited for a text in schools offering courses in metallurgy.

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- Agricultural equipment
- Railway equipment and rolling stock
- Heavy machinery and machine tools
- Light machinery, instruments
- Electrical equipment and appliances
- Hardware, cutlery and tools
- Building equipment and products
- Process industries equipment
- Ordnance
- Ships, boats, marine equipment

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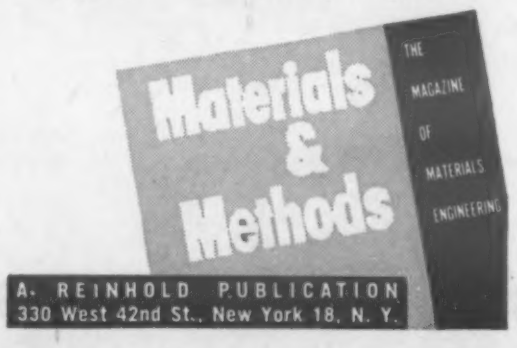
- Equipment and methods which change the surface properties or appearance of materials
- Equipment and methods for joining materials



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EDITORIAL

Better Materials Choices Needed

From time to time we have sounded off in these columns about the value of materials engineers and materials engineering. Perhaps it has done some good, perhaps not. The fact remains that the proper selection and application of materials is becoming more important in direct relationship to the movement of many goods into a buyers' market.

The situation was brought to mind very strongly a few days ago when I encountered a business friend.

"You're editor of a materials magazine," he greeted me. "Why can't you do something about the poor materials being used in so many things today?"

He had beefs—and legitimate complaints they were—against an automobile, an oil burner, an electric sweeper and an electric razor. All were purchased at a time when there should have been no excuse for inferior materials.

In the oil burner a vital part kept failing because it was not selected with a view to standing-up under the heat it encountered. Replacement after replacement met with the same result. His was not an isolated case, for an entire group of house owners in the same development had similar experiences. The oil burners were made by a well established manufacturer who has now lost considerable good will.

With the vacuum cleaner, our friend found that the materials used in the switch could not stand the strain of ordinary usage. Here again several replacements brought little more than temporary relief. My friend is going to be hard to sell on that make of cleaner again.

As a wedding gift, my friend gave a new type of electric razor. His gift came back to him in short order. It wouldn't work after the first few days. Investigation revealed the fact that this product had not been tested before putting it on sale.

It would seem that these few instances would point up two important truths:

1. You can't spend too much time choosing a material for any product that is normally expected to give more than momentary service life. If you don't know, there are all types of information sources. Use them.
2. Regardless of what the specifications of the material may read, try the materials in their intended application under conditions as near to actual service conditions as is possible.

Time and money spent in this manner will be small compared to the cost in time, money and reputation that can result from one little material misapplication.

T. C. Du Mond
Editor

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Index of Feature Material

MATERIALS & METHODS

Volume 30

July—December 1949, Inclusive

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